

AN INTRODUCTION TO ASTRONOMY AND GEOGRAPHY: BEING A plain and easie TREATISE OF THE GLOBES.

In VII Parts.

Containing

- I. The Definitions of the *Lines, Circles, &c.* upon the *Globe or Sphere*; and of several Terms of Art.
- II. The *Problems in Astronomy* Methodically digested, with variety of *Examples*.
- III. The several affections of *Triangles*, and their Solution upon the *Globe*; with the variety of *Problems* which every *Case* contains.
- IV. The whole Art of *Dyalling* demonstrated and performed two several ways.
- V. The Erection of an *Astrological Figure* of the Heavens, according to the several ways of the *Ancient and Modern Astrologers*.
- VI. & VII. The Explanation and Uses of the *Terrestrial Globe*, with a brief *Geographical and Hydrographical Description* of the Earth and water.

By WILLIAM LEYBOURN.

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THE
PUBLISHERS
TO THE
READER.



That nothing is at once brought forth and perfected, is an observation we may make, as from other things, so in a more especial manner from Arts and Sciences: but not to speak of all, which yet have had, in Succession of time, their Accessions to perfection; we shall instance only in these of Astronomy and Geography. And certain it is, should we either seriously compare the Works of the Antients, with the more accurate observations and additions of our modern Astronomers; what just cause would appear, for that correction and alteration which is now made? And should we com-

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pare the Geographical Tables or Charts of the Antients, with the more perfect discoveries of our later times ; what defects and errours shall we there discover ? We hope therefore you will not think strange, because we have so much dissented in our Globes, Maps, &c. from those that now only are accounted excellent ; for as we cannot consent to copy those errours and abuses which the Dutch would impose upon the whole world, so we cannot altogether pass by our English Map-makers without censuring them for reasons which we might, and the less curious may by their own Works themselves perceive. But as we well know no Art is at once perfected, so we well know there are abroad in the world many Books and Instruments conducing to the improvement of the Mathematicks, whereof some are superfluous, others burdensome. The consideration whereof was prevalent enough to have clouded this under the opake darknes of Latencie, had it not been drawn upon the Horizon of publick view, by two irresistible Magnets,

The time and season of its undertaking was to us too disadvantageous to the rendering a Work of this Nature so compleat,
and

to the Reader.

and in such good order as was requisite; being necessarily forced and confined to our daily Employment, so that we could never have Effected it, had not Mr. Leybourn, knowing our occasions, willingly assented to Calculate and Methodize all the Problems for us; which Favour we cannot but thankfully acknowledge and confess. As for the Subject of this Treatise, it being Astronomy and Geography, needs no Commendation where there are noble Men, or noble Mindes.

All therefore we shall say of Astronomy is, that 'tis of such important consequence, that without the knowledge and science thereof, how great uncertainty in times and seasons, what distracting confusion in humane affairs must we necessarily be involved in? And for Geography, all that need to be spoken of it is, that 'tis so noble a Study, and of such grand importance, as Kings and Princes have made it their highest concern to understand. Wherefore that the one might be the more easily apprehended, and the other most truly represented to our view and fancy, the Antients, with the consent of succeeding Ages, have with much pains and industry, not only invented, but also commended

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wended to Posterity the Sphere or Globe, which also have had their Corrections and Amendments. And here we must say something of those New Globes lately set forth by our selves.

True it is, we might boast of the help and assistance of the ablest Mathematicians, not only in England and Holland, but in other parts also; yet sure we are, that after many years experience, not only in the making and projecting of Globes, Maps, &c. but also in examining and comparing of the Descriptions, Discoveries, Drafts, Journals, Observations, and Writings, as well of Antient as Modern Geographers, Astronomers, Seamen, and others, wherein we have spared no pains or cost, that we might deliver the delineations of the Earth from the Ataxie and confusion of former Globes and Maps. We say, although 'tis impossible we should emit and set them forth in that exactness and perfection they ought, and we could wish; yet doubtless we have and shall expose both Globes, Spheres, Maps, &c. more accurate and compleat than some trifling Toys, as well Forrain as Native, which have been sold at great rates by others, and that with much Ostentation and

Boa-

to the Reader.

Boasting; to the abuse of some Gentlemen, perhaps better stored with Money, than Knowledge or Judgement in such things. As for the excellencie of the Globe or Sphere, all we shall say is, that they have the Priority in Nature of all other Instruments, as most fit and convenient to the Understanding and Fancie; not to speak any thing of them as they analogically represent the Heavens and the Earth in proper genuine Figures: for, that the Heavens are round, is not doubted by any; and for the form of the Earth, the Opinion of its rotundity is now generally known and received.

Our only Request therefore is, that if (in so great a Circumference as we have run) some Lines be not truly drawn from the Centre, that they may not draw an Oblique Censure from the Reader, but rather thy Animadversion and Pardon for

ROB. MORDEN,

W. BERRY.

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Astronomical Definitions.

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The Rudiments of Astronomy,

AND

Explanation of the Sphere & Globe.

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What a Sphere is.



Sphere (omitting the Geometrical denomination) in relation to my present purpose, I define to be, *An analogical representation of the Heavens and of the Earth, made of several Circles so fitted together,*

as thereby the better to express and represent to the Fancie the Systeme or Hypothesis of the Visible World. Of which there are chiefly three sorts invented, viz. the Ptolomean, Copernican, and Tychoonian.

A Description of the Ptolomean sphere.

This Systeme (which was so called from Ptolomy the Prince of Astronomers, being indeed the very Founder of that Art and Science) supposeth the Earth to be fixed in the Centre immoveable, and that all the Celestial Bodies do move round that in their Diurnal and Annual revolutions. This sphere

Astronomical Definitions.

of Systeme of the World the Ancients divided into two Parts or Regions; *Elemental*, and *Celestial*. The first consisteth of four Parts: 1. The Earth. 2. The Water. Which together maketh one perfect Body. And above these, are the other two Elements, *viz.* 3. the Air; and above that, 4. the Fire. The second consisteth of many parts, *viz.* 1. The Moon. 2. Mercury. 3. Venus. 4. The Sun, 5. Mars. 6. Jupiter. 7. Saturn. 8. The Orb or Sphere of the *Starry Heaven*: all which Orbs or Circles are imagined to be carried about upon the *Axis* of the World, by the rapture of the *Primum Mobile*, as is represented by this Figure.

Of the Several Motions of the Planets.

Besides the Diurnal motion by which the Planets are carried round about from East to West in 24 hours by the rapture of the *Primum Mobile* upon the Poles of the World, they have also a free and proper motion of their own, from West to East, according to the succession of the Signes upon the Poles of the *Ecliptick*, each of them in a several manner and space of time: *viz.* The Moon, which is the lowest of the Planets, makes her Revolution in 29 days and 8 hours. The next is Mercury, who is never far distant from the Sun, and finisheth his motion in 88 days. Then Venus, which in her preceding the Sun is called *Lucifer*, but in her following the Sun is called *The Evening Star*, finisheth her revolution in 225 days. Next the Sun, who performeth his revolution in the space of a year, *viz.* 365 days, and about 6 hours. The next is Mars, who finisheth his course in one year,

Astronomical Definitions.

year, and 331 days. Then *Jupiter*, who maketh his revolution in 11 years, 10 months, and 16 days. Lastly, *Saturn* the highest of all the Planets, and therefore goeth the greatest circuit, finisheth his periodical course in 29 years, 5 months, 15 days. Now all these Orbs in our large *Ptolomian* Spheres are placed upon the Poles of the *Ecliptick*, the better to correspond with their real places, and demonstrate their true motions in the Heavens.

A description of the Copernican Sphere.



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whole Universe, from whence he may the more equally communicate and distribute both light and heat to the rest of the opacous Planetary Bodies encircling him. The first next the *Sun* is *Mercury*, who finishes his Circuit about the *Sun* in 88 days. The next is *Venus*, who moveth round the *Sun* in 225 days. Next is the *Earth*, which is supposed to move with a double Motion: one about its own Centre, upon the Pole of the Equinoxial, from West to East, in 24 hours; whereby all its

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Astronomical Definitions.

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Astronomical Definitions.

3

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A description of the Copernican Sphere.

This Hypothesis is now known to the world by this name, from *Copernicus* a *Borussian*, and Canon of the Cathedral Church of *Worms*, who seriously addressing himself to the illustration of Astronomy, revived the long-neglected System of the World excogitated by *Pythagoras*, a Figure whereof is here inserted.

Of the Motions of the Planets.

In this System the rest of the Planets are moved round the *Sun*, which is the Centre of the whole Universe, from whence he may the more equally communicate and distribute both light and heat to the rest of the opacous Planetary Bodies encircling him. The first next the *Sun* is *Mercury*, who finishes his Circuit about the *Sun* in 88 days. The next is *Venus*, who moveth round the *Sun* in 225 days. Next is the *Earth*, which is supposed to move with a double Motion: one about its own Centre, upon the Pole of the Equinoxial, from West to East, in 24 hours; whereby all its

B 2

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4 Astronomical Definitions.

parts are alternately enlightned, and Day & Night successively enjoyed: the other Motion is made upon the Poles of the Zodiac or Ecliptick, in the space of a year; whereby all places by course enjoy Spring, Summer, Autumn, and Winter. The *Earth* is encompassed with a Circle which doth not include the *Sun*, representing the Orb of the *Moon*, who in 29 days and a half finisheth her period round the *Earth*. The next is *Mars*, who is moved above the *Earth* and *Moon*, and ends his course round the *Sun* in the space of one year and 320 days, or thereabouts; and appears far greater when he is in Opposition of the *Sun*, than he doth at other times; at which time he is five times nearer the *Earth*, than he is in his greatest remotion. The next is *Jupiter*, who with his four companions moveth above *Mars*, and is about 12 years encompassing his period round the *Sun*. The seventh is *Saturn*, who with his Ring and *Moons* is about 30 years in finishing his revolution round the *Sun*. And lastly, the Sphere of the *Fixed Stars*, which with their several distances encircle all the *Planetary Orbs* immoveable, and to us incommensurable.

I shall not now need plead for the truth of this System, nor speak much of its excellencie: onely this; That hereby is taken away that incredible daily motion of the Planets, and vast Orb of the fixed Stars; which are, if the Antients Supputation should be true, many hundred times swifter than the Shot out of any Gun: for the motion of the *Sun* in one hour must be 785715 English miles, and in one minute 13095 miles more; and the fixed Stars must move in an hour 13513686 Eng-
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Astronomical Definitions.

lish miles, and in one minute 225228 miles. And also hereby is annihilated all those Epicycles which the old Astronomers blindly tyed to the motion of the *Sun*; and all those Eccentricks, Differents, and Equants, with the Circles of Inclination, Deviation, and Reflexion. This Hypothesis, without any absurdity or perplexity of fictitious Orbs, or impertinent motions, exactly solves all the variety of appearances in the Heavens.

A description of the Tychonian Sphere.



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the *Earth* the Centre to the *Sun*, *Moon* and *Stars*, which also have their motion round the *Earth*; but the rest of the Planets to move round the *Sun* as their Centre: *Saturn* in opposition to the *Sun* to be nearer to the *Earth* than *Venus* in her *Apogee*, and *Mars* in opposition is nearer to the *Earth* than the *Sun* it self; as may be seen by the Figure.

But for a further illustration, or satisfaction to the more Curious, I shall commend them to a sight of

4 Astronomical Definitions.

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I shall not now need plead for the truth or this System, nor speak much of its excellencie: onely this, That hereby is taken away that incredible daily motion of the Planets, and vast Orb of the fixed Stars; which are, if the Antients Supputation should be true, many hundred times swifter than the Shot out of any Gun: for the motion of the Sun in one hour must be 785715 English miles, and in one minute 13095 miles more; and the fixed Stars must move in an hour 13513686 English

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A description of the Tychoonian Sphere.

This Hypothesis derives its name from that Noble Dane, *Tycho Brabe*, who with an Heroical Bravery enterprised no less than the Instauration of the whole Science of Astronomy from its very Fundamentals; laying such solid Foundations, as that he came very neer the height of his noble hopes of building the whole Theory of Astronomy anew: but being prevented by death, he could not accomplish his noble Digne. He, I say, excogitated this Hypothesis; which all those that cannot allow of the *Ptolamaick*, nor adhere to the *Copernican*, may accept and approve of: wherein he makes the *Earth* the Centre to the *Sun*, *Moon* and *Stars*, which also have their motion round the *Earth*; but the rest of the Planets to move round the *Sun* as their Centre: *Saturn* in opposition to the *Sun* to be neerer to the *Earth* than *Venus* in her *Apogee*, and *Mars* in opposition is neerer to the *Earth* than the *Sun* it self; as may be seen by the Figure.

But for a further illustration, or satisfaction to the more Curious, I shall commend them to a sight of those

6 Astronomical Definitions.

those New Spheres lately set forth by the Publishers of this Book, being more exactly and accurately made and contrived than those formerly done, and will be procured at a more reasonable rate; and in operation may be applied to Practical uses, as the Globe is.

What a Globe is.

A Globe is an Artificial representation of the *Starry Heaven*, or the *Earth* and *Water*, under the form and figure of Roundness which they are supposed to have, shewing, in a just proportion and distance, every particular Constellation in the *Heavens*, and each several Region or Country on the *Earth*.

Of the Poles.

A Globe hath two Poles: the one is called the *Arctic*, or North-Pole; the other the *Antarctic*, or South-Pole; representing the Poles of the World.

Of the Axis.

From the Centre of the Globe is imagined a line thorow both Poles, which is called the *Axis* of the world, and is represented by the two Wyers in the Poles of the Globe.

Astronomical Definitions.

7

Of the Brazen Meridian.

Every Globe is hung by the *Axix* at both the Poles in a Brazen Meridian, which is divided into 360 Degrees, or four times 90 equal parts. The reason why this Circle is thus divided into four Nineties, is because the Elevation of the Pole, or Latitude of the place, cannot be above 90 degrees.



Index.

A small Brass-circle is fixed to the Globe, and is used for finding the hours of the day, or the revolution of the Sun, by an Index, which is a small Brass-circle, that moves upon the Meridian of Altitude.

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Of the Horizon.

Besides the body of the Globe, there is also annexed a certain Frame of wood, which is called the *Horizon*; in the upper Plane whereof are several Circles delineated. The first or inner Circle is

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Of the Brazen Meridian.

Every Globe is hung by the *Axix* at both the Poles in a Brazen Meridian, which is divided into 360 Degrees, or four times 90 equal parts. The reason why this Circle is thus divided into four Nineties, is because the Elevation of the Pole, or Latitude of the place, cannot be above 90 degrees.

Of the Hour-circle, and Index.

Upon every Meridian is fitted a small Brass-circle, whose centre is the Pole of the Globe, and is divided into 24 equal parts, representing the hours of the Day and Night; which in the revolution of the Globe is pointed to with an Index, which is fitted on the *Axix* of the Globe.

Of the Quadrant of Altitude.

There is also another appendant relating to the Meridian, called *The Quadrant of Altitude*; which is a thin Brass-plate divided into 90 equal parts or degrees, and fitted with a Nut and a Screw, to move to any degree upon the Meridian.

Of the Horizon.

Besides the body of the Globe, there is also annexed a certain Frame of wood, which is called the *Horizon*; in the upper Plane whereof are several Circles delineated. The first or inner Circle is

8 Astronomical Definitions.

divided into equal Parts or Signes ; every Signe having its name, nature and character placed to it ; and every Signe subdivided into 30 equal parts called *Degrees*, and numbered with 10 20 30. Next to the Circle of Signes is a Kalendar or Almanack according to the Old Stile used by us here in *England*, called the *Julian* ; which is divided into the 12 Months of the year, viz. *January, February, &c. to December* ; every Month being subdivided into its number of days : whereunto is annexed the Festival days. Next is a Kalendar of the New Stile, now used in many forreign places, instituted by Pope *Gregory* the 13 ; in which the Months begin 10 days sooner than they do in the other. The last is a Circle of the Winds, divided into 32 equal parts, called *Points of the Compass*, according to the number of Winds which are observed by our modern Navigators ; by which they designe forth the Quarters of the Heavens, and the Coasts and Bearings of Countries.

Of the Cœlestial Globe.

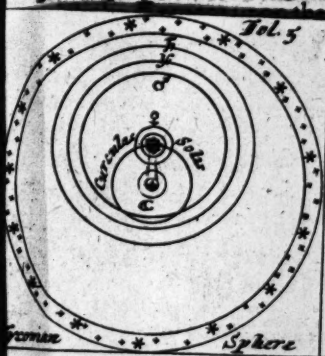
THE *Starry Heaven*, that glorious Canopie embroidered with those sparkling Diamonds which hang upon the duskie cheeks of the Night, as a rich Jewel in an *Æthiops* ear, is represented unto us by the Cœlestial Globe, because upon its convexity are artificially placed all the Stars and other appearances, in that order and place as they are naturally situate in the concavity of that Orb or Heaven.

Of the Lines, Circles, &c. upon the
Celestial Globe.

And first,

Of the Equinoxial.

This is a great Line encircling the Globe, equally distant from both the Poles, and is divided into 360 equal parts or degrees: it is the same Line



Terrestrial Globe; one-
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Equinoxial.

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because that the Fixed Stars have not at all changed their situation in respect of Latitude: Therefore the other must needs be granted, viz. the Motion of the Equinoxial. Hence it comes to pass, that the Stars being fixed in their own Orb, move not, but are by the precession of the Equinox left behinde the Equinoxial Colure, and so alter their Longitudes. For the first Star of Aries, which in the time of Meton the Athenian (who lived about

8 Astronomical Definitions.

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Of the Lines, Circles, &c. upon the Cœlestial Globe.

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Of the Equinoxial.

This is a great Line encircling the Globe, equally distant from both the Poles, and is divided into 360 equal parts or degrees: it is the same Line with the Equator upon the Terrestrial Globe; only that remains fixed and unmoveable, this variable, or at least must be imagined to move in the Heavens.

Of the Motion of the Equinoxial.

For one of these two must needs be granted; either the Motion of the Eighth Sphere, or Starry Orb, from West to East upon the Poles and Axis of the Ecliptick; or else the progress of the Equinoxial points into the precedent Signes. Now that the first is not to be admitted, appears manifestly, because that the Fixed Stars have not at all changed their situation in respect of Latitude: Therefore the other must needs be granted, viz. the Motion of the Equinoxial. Hence it comes to pass, that the Stars being fixed in their own Orb, move not, but are by the precession of the Equinox left behinde the Equinoxial Colure; and so alter their Longitudes. For the first Star of Aries, which in the time of Meton the Athenian (who lived about

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431 years before Christ's time) was in the very *Perpetual* Interfection; in the year 1572, when Tycho observed it, was found to be in 27 deg. 37 min. of *Aries*; and will, according to his Opinion, finish its revolution in 25412 years.

Of the Ecliptick.

The Equinoxial is crossed or cut in two opposite points by an oblique Circle, called the *Ecliptick*; which divides the Globe into two equal parts, called *Hemispheres*; the one the Northern, the other the Southern. This Circle is divided into 12 equal parts, which are called the 12 *Signes*; every part being marked with the Figure, Character, and Name of the Signe belonging to it; and each of these Signes is divided into 30 equal parts called *Degrees*. Under this Circle the *Sun* and the rest of the Planets finish their several Courses. It is called *Via Solis*, because the *Sun* always goes under it in its annual course: but the rest of the Planets have all of them their latitudes and deviations from this Line; by reason of which their digressions and extravagancies, the Ancients assigned the Ecliptick 12 degrees of Latitude: but modern Astronomers, by reason of the evagations of *Mars* and *Venus*, have added to each side two degrees more; so that the whole Latitude is confined to 16 degrees: which breadth is also called by some the *Zodiack*.

Of the Poles of the Ecliptick.

As all the Meridians described upon the Globe meet

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meet in the Poles of the World ; so all the Circles of Longitude being drawn thorow the 12 Signes, meet in the Poles of the Ecliptick ; each Pole of the Ecliptick being distant from its correspondent Pole of the World 23 deg. 30 min. the one is called the *North-pole*, the other the *South*, according to their position next the North or South-poles of the world.

Of the Colures.

The Colures are two great Circles cutting one another at Right-angles in the Poles of the World, the one passing by the beginning of *Aries* and *Libra*, two Equinoxial-signes, and is therefore called the *Equinoxial-Colure* ; the other passing thorow *Cancer* and *Capricorn*, two Solstitial-signes, and is therefore called the *Solstitial Colure*. This passeth thorow the Poles of the World, and also of the Ecliptick ; but the other passeth thorow the Poles of the World onely. The Colures divide the Ecliptick into four equal parts ; viz. into *Aries*, *Cancer*, *Libra*, and *Capricorn* ; which are called the *Cardinal points* : for according to the *Sun* approach unto any of them, the Season of the year is altered into *Spring*, *Summer*, *Autumn*, and *Winter*.

Of the Tropicks.

Parallel to the Equinoxial, there are two small Circles, which are called the *Tropicks* ; and are 23 deg. and a half distant from the Equinoxial, and are the bounds of the Ecliptick. That on the North-

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North-side of the Ecliptick is called *The Tropick of Cancer*, where the Sun hath the greatest North-declination; and makes our longest day and shortest night; which is about the 11 or 12 of June. The other, on the South-side of the Equinoctial is called *The Tropick of Capricorn*, in which point the Sun hath its greatest Southern declination, making our shortest day; and longest night; which is about the 11 or 12 of December.

Of the Arctick and Antarctick Circles.

Twenty three degrees and a half from either Pole, are described two small Circles: that near the North-pole is called *The Arctick Circle*, the other in the South is called *The Antarctick Circle*.

Of the Number of the Stars.

Encircling the Terrestrial Orb at unmeasurable distance, sparkle the innumerable Lights or Stars in the immense Expansion of the Firmament. And although the Number of them for multitude seems innumerable, yet the greatest and more visible may be numbered and named. The Number that Astronomers have at present taken notice of, is about 1400; which we have inserted in our New Celestial Globe, according to their Right Ascensions and Declinations, and are sufficient for any use or purpose whatsoever.

Of the Magnitudes of the Stars.

For the better distinction of the bigness of the Stars

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Stars, they are divided into 6 degrees of Magnitude. The biggest and brightest are called *Stars of the first Magnitude*; those next inferior in bigness and brightness are called *Stars of the second Magnitude*; and so the Stars gradually decrease to the sixth Magnitude, which is the smallest, except some few, which are called *occult*, or *nebulous*. And these several Magnitudes are expressed on the Globe in several shapes, as may be seen in a small Table placed for that purpose on our Celestial Globe.

Of the Images or Constellations described upon the Celestial Globe.

Astronomers desirous to bring the Stars into Order and Method, have reduced many Stars into one Constellation, the better to tell where to seek them; and being found, how to express them. The number of Constellations now drawn upon the Globe are 64: viz.

In the Northern Hemisphere.

Ursa minor	20	Cygnus	27	Antinous	19
Ursa major	55	Cassiopeia	45	Delfinius	10
Dracon	32	Perseus	33	Equuleus	14
Cepheus	11	Auriga	27	Pegasus	23
Bootes	28	Serpentarius	38	Andromeda	23
Corvus Borealis	8	Serpens	13	Triangulus	4
Hercules	28	Sagitta	8	Coma Berenice	15
Lyra	11	Aquila	15	In all,	472

In the 12 Signes of the Zodiack,

<i>Aries</i>	21	<i>Leo</i>	40	<i>Sagittarius</i>	28
<i>Taurus</i>	49	<i>Virgo</i>	39	<i>Capricornus</i>	29
<i>Gemini</i>	29	<i>Libra</i>	18	<i>Aquarius</i>	41
<i>Cancer</i>	15	<i>Scorpio</i>	26	<i>Pisces</i>	36
					In all, 371

In the Southern Hemisphere,

<i>Cete</i>	21	<i>Centaurus</i>	40	<i>Pavo</i>	23
<i>Orion</i>	62	<i>Crusero</i>	5	<i>Avis Indica</i>	11
<i>Eridanus</i>	42	<i>Lepus</i>	25	<i>Musca</i>	4
<i>Lepus</i>	13	<i>Ara</i>	10	<i>Chameleon</i>	10
<i>Canis major</i>	15	<i>Corona Austral.</i>	17	<i>Triangulum</i>	5
<i>Canis minor</i>	5	<i>Columbus</i>	10	<i>Piscis volans</i>	7
<i>Argo navis</i>	68	<i>Piscis Austral.</i>	13	<i>Dorado</i>	7
<i>Hydra</i>	24	<i>Grus</i>	13	<i>Toucan</i>	8
<i>Crater</i>	8	<i>Phoenix</i>	15	<i>Hydrus</i>	21
<i>Corvus</i>	7	<i>Indus</i>	12	In all, 510	

To these is lately added, by Sir Charles Scarborough, a Constellation called *Cor Caroli Regis*, figured with a Crowned Heart; being a very considerable and notable Star of the second Magnitude, and unformed, lying between *Ursa major* and *Coma Berenices*; and 'tis well worthy the observation and notice of the more Curious.

Of the Via Lactea, or Milkie way.

This is a broad White Circle that is seen in the Heavens, and is described between two tracts of small pricks running through several Constellations

ons round the Globe. It is caused by a great number of little Stars conspicated in that part of Heaven so small and thick, that we can perceive nothing but a confused light. About the Southern Pole are also discovered two white spots, seeming to be onely two white Clouds, being a pale assembly of very small Stars, as in the *Galaxy* or *Milkie way*; which are more clearly discovered by the *Telescope*, otherwise inconspicuous to our eyes.

An Explanation of several words of Art.

And first,

of Azimuths.

A *Zimuth*, or *Vertical Circle*, are great Circles passing through the *Zenith* and *Nadir*: and as the *Meridians* cut the *Equinoxial* at Right-angles, so the *Azimuths* cut the *Horizon* at Right-angles; and are numbered by degrees from the East to the West-point, towards the North and South in the *Horizon*.

Almicanters.

These are *Circles* parallel to the *Horizon*, whose Poles are in the *Zenith* and *Nadir*; and are called *Circles of Altitude*, because when the *Sun*, *Moon*, or any *Star* is in any number of degrees above the *Horizon*, it is said to have so many degrees of *Altitude*. And these *Almicanters*, or *Circles of Altitude*,

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tude, are numbered upon the Vertical Circle, from the Horizon upwards towards the Zenith.

Amplitude.

The *Amplitude* is an Arch of the Horizon, or the number of degrees contained between the true East and West-points in the Horizon, and the rising or setting points of the *Sun*, *Moon*, or *Star*.

Ascension.

Is the rising point of any *Star*, or any part or point of the Equinoxial above the Horizon.

Right Ascension.

The *Right Ascension* of the *Sun*, *Moon*, or *Star*, is the number of degrees upon the Equinoxial comprehended between the first point of *Aries* and the Arch of another Meridian passing through the centre of the *Sun*, *Moon*, or *Star* which is upon the Meridian at the time proposed.

Oblique Ascension.

Oblique Ascension is the Arch or number of degrees of the Equinoxial, which riseth with the *Sun*, *Moon*, or any *Star* in an Oblique Sphere.

Oblique Descension.

Oblique Descension is the Arch or number of the degrees of the Equinoxial which, setteth with the *Sun*, *Moon*, or *Star*.

As-

Ascensional difference

Is the number of degrees after the subtraction of the *Oblique Ascension* from the *Right Ascension*; or the difference between the Ascension of any point of the *Ecliptick* in a *Right Sphere*, and the Ascension of the same point in an *Oblique Sphere*.

Apogæum

Signifies that point of the Heavens where the *Sun* or any other Planet is farthest from the centre of the Earth.

Perigæum

Is that point of the Heavens wherein the *Sun* or any Planet is nearest the centre of the Earth.

A Circle

Considered as it hath some ground in the nature of the Heavens or the Earth, at least by Application, is by Astronomers and Geographers divided into 360 parts or degrees: not because this division hath any ground in Nature more than another, but because this number is most commodious for the distinction of Circles, and fittest for Calculation, because no number suffers more parts or divisions than this.

Of the Compass of the Earth.

Now because the whole Circumference of a Circle is 360 degrees, therefore the Compass of the Earth, according to this supposition, must be 21600 miles. But this opinion seems to be taken (or rather mistaken) from *Ptolomy*, who allows 500 *Stadiums* in a deg. and to every *Stadium* 600 feet: so that it being proved that 5 *Egyptian* or *Alexandrian* feet are longer than 6 of the *Italian*, and the *Romane* or *Italian* is longer than our *English*; it is evident that there is no sufficient ground for this opinion, and therefore ought to be better considered of.

A Constellation.

A *Constellation* or *Asterism* is, a certain number of *Stars* gathered together into one form, representing some living creature, or other thing, whereby they are particularly known.

Complement

Is here usually taken for the remainder of the number of degrees and minutes that any part of a Circle wants of 90 degrees. As, suppose the Latitude of a *Star* be 50 degrees, that being subtracted from 90 degrees, or the fourth part of a Circle, called a *Quadrant*, there remains 40 degrees for the Complement thereof.

of a Degree.

'Tis a common Opinion, that 5 of our *English* Feet make a Geometrical Pace; 1000 of those Paces make an *Italian* or *English* Mile; and 60 of those Miles in any great Circle upon the Spherical surface of the Earth or Sea, make a Degree.

So that a degree of the Heavens contains upon the surface of the Earth; according to the Opinion of the Ancients,

60	{ <i>English</i> } Miles.
	{ <i>Italian</i> }
20	{ <i>French</i> } Leagues.
	{ <i>Dutch</i> }
15	<i>German</i> Miles.
17½	<i>Spanish</i> Leagues.

But according to several Experiments made, the quantity of a Degree is thus variously found to be;

by	{ <i>Albazard the Arabian</i> } 73	} <i>English</i> Miles.
	{ <i>Fernlius</i> } 68	
	{ <i>Wilbrordus</i> } 70	
	{ <i>Gassendus</i> } 73	
	{ <i>Oughtred</i> } 66	
	{ <i>Norwood</i> } 69	

Declination

Is the number of degrees that the *Sun* or any *Star* is distant from the *Equinoctial* towards either Pole; and hath a double denomination, viz. *North* or

South-declination, according as the *Sun* or *Star* is on the North or South-side of the *Equinoctial*.

Of Eclipses.

An Eclipse is a privation or want of light in an opacous or dark Body which is beheld or aspected by a luminous Body : and these Eclipses are of two sorts.

Of the Eclipse of the Sun.

The Eclipse of the *Sun* is nothing else but the interposition of the *Moon* between our sight and the *Sun*. For the *Moon* being of a dark, solid, and opacous body, coming between the *Sun* and the *Earth*, doth thereby hide more or less of the *Sun*'s bright-shining body from our sight, so that the *Earth* (improperly the *Sun*) is Eclipsed. This Eclipse cannot be universal (as the *Moon*'s Eclipse is) but may appear in one Country a greater Eclipse, in another lesser, and in other some no Eclipse at all. For seeing the *Sun* far exceedeth the *Earth* in bigness, and the *Earth* far exceedeth the *Moon* : therefore the Cone of the *Earth*'s shadow cannot take away or hide the whole body of the *Sun* from all parts of the *Earth*, but one part onely shall observe the same to be total, or of a like quantity.

Of the Eclipse of the Moon.

The *Moon* having no light but what she receiveth of the *Sun*, can never be Eclipsed but at the Full :

Full: yet not at every Full, but when she is diametrically opposite to the *Sun*, and the *Earth* in the midst between them both. For the *Earth* being a solid and opacous Body, casteth its shadow to that point which is opposite to the *Sun*. So that Conjunction and Opposition onely makes an Eclipse; which so happens, when the centre of the *Earth* and the centres of both the *Sun* and *Moon* shall be in the same line: which can onely be, where the *Moon's* Eccentrick cutteth the *Sun's* in that line which is called the Ecliptick. This intersection, which can be but in two places, is called the *Nodes*, or Dragon's head and tayl. Not does this intersection keep one certain place, but moving, make a Circle of 18 years. So that Eclipses being Periodical, an Eclipse of the *Moon* happening now, shall 18 years hence come to pass in the same Signe again.

Horizon

Is taken from the boundary or termination of the light, and is twofold: Natural, and Astronomical. The Natural *Horizon* is that apparent Circle which divides the visible part of Heaven from the invisible; extending it self in a straight line from the superficies of the *Earth* every way round about the place you stand upon, dividing the Heavens into two unequal parts; which is designed out by the light, and is sometimes greater or lesser, according to the condition of the place.

The Astronomical *Horizon* is that great Circle that divides that part of Heaven which is above us, from that part which is under us, exactly into

two equal parts, always certain and the same, passing thorow the Centre of the *Earth*, whose Poles are the *Zenith* and *Nadir*. In this Circle, the *Azimuths* or Vertical Circles are numbered; and by this Circle our days and nights are measured. This Circle is represented by the upper Plane of the Wooden Horizon.

Of the Sun's Longitude.

The Longitude of the *Sun* is an Arch of the *Ecliptick* comprehended between the Circle of Longitude passing thorow the first point of *Aries*, and another Circle of Longitude passing thorow the Centre of the *Sun*.

Of the Longitude of a Star or Planet.

The Longitude of a Star or Planet is properly an Arch of the *Ecliptick* comprehended between the Semicircle of Longitude passing thorow the beginning of the Signe the Star or Planet is in, and the Semicircle of Longitude passing thorow the Centre of the Star or Planet.

Of the Latitude of the Moon, Star or Planet.

The Latitude of the Moon, Star or Planet, is their distance from the neereſt point of the *Ecliptick* either North or South, or an Arch of a Semicircle of Longitude comprehended between the *Ecliptick* and the Star or point enquired after.

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Magnetical Meridian

Is an *Azimuth* that passeth by the points of the Needle touched with the Loadstone, or that which passeth through the Poles of the Magnetical Variation.

Magnetical Azimuth of the Sun

Is an Arch of the Horizon contained between the *Magnetical Meridian* and the *Azimuth* of the Sun.

Azimuth of the Sun

Is an Arch of the Horizon comprehended between the *Azimuth* passing thorow the Centre of the Sun, and the true Meridian.

Of the several Positions of the Globe or Sphere.

Whereas in the resolving Problemes (of what kinde soever) upon the Globes, some there are which may be performed the Globe being in any position or situation, having no need of Rectification; as in *Astronomy*, the Longitude, Place, or Declination of the Sun; the Longitude, Latitude, Declination and Distances of Stars upon the *Celestial Globe*. In *Geography*, the Longitude, Latitude, and Distance of places by the *Terrestrial*

Globe. Also several Problems may be resolved by the help of some one single Circle, either such as is described upon the Globe it self, or is otherwise appendant unto it. As in *Geography*, the difference of Longitude between Country and Country by the *Equinoxial* or *Hour Circle*; the Latitude and difference of Latitude of Places, by the *Meridian*. In *Astronomy*, the Declination of the *Sun* or *Stars*, by the *Meridian*; the distance of *Stars* in the Heavens, or of *Places* upon the Earth or Sea, by the *Quadrant of Altitude*. The day of the Month, *Sun's* place and declination upon the *Horizon*; with divers other the like Conclusions.

But for the resolving of most Problems, it will be requisite to have the Globe placed or fitted according to some assigned Position or Elevation, such as the tenour of the Question shall require. And, besides the Globe it self, and the Circles described upon it, such also as are appendant unto it must come in use; as the General Meridian, Horizon, Quadrant of Altitude, Hour-circle, and Circle of Position, must be accordingly rectified.

Now there are but Three Positions in which the Globe can be said to be rectified; of which, two are particular, and the third more general. For,

Of a Direct Sphere.

I. The Globe may be so placed in the Frame of the Horizon, that both the Poles thereof may rest upon (or lie directly in) the North and South points of the Horizontal Circle, neither Pole having any Elevation, the Zenith-point being in the Equinoxial Circle, and the Axis of the world directly

rectly in the plain of the Horizon : and so the people living under that Circle have no Latitude, the Pole having no Elevation.

The Globe or Sphere being in this position, is said to be in a *Direct* position, the Zenith being directly in the Equinoxial Circle, and the Poles of the world directly in the North and South points of the Horizon : and this *direct* position of the Sphere is particular to those who live under the Equinoxial, who have one benefit and privilege above all the inhabitants of the world besides, for that they can see both the Poles, and behold all the Stars (in both Hemispheres) to rise, culminate, and set.

Of a Parallel Sphere.

II. The Globe may be so placed in the Frame of the Horizon, that one of the Poles shall be in the *Zenith*, and the other in the *Nadir*-points; that is, either Pole shall be 90 *deg.* (or one quarter of a Circle) distant from the Horizon on either side thereof; and in this position will the Equinoxial Circle be in the Horizon, and the Axis of the world will cut both the Equinoxial and the Horizon at Right-angles; one Pole having 90 degrees of Elevation, and the other as much of Depression.

The Globe or Sphere being in this position, is said to be *Parallel*; because the Equinoxial, and all the Circles of Declination, (which now are Circles of Altitude also) and the Axis of the world it self, do lie all of them Parallel to the Horizon. And those people (if any be) that inhabit these parts of the

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the world, see onely those Stars that are between the Equinoxial and the Elevated Pole ; that is, if the South-Pole be elevated, they see the Southern ; and if the North-Pole be elevated , they see the Northern Constellations onely. And those people have but one day and one night in the whole year , and those most miserable cold, not to be imagined : for the Sun, at his highest, never extendeth to 24 degrees of Altitude ; which is no more than it is with us in *London* at Noon upon the 14 or 15 of *February*. And this position of the Sphere is particular to these inhabitants onely.

Of an Oblique Sphere.

III. The third (and most usual) position of the Sphere or Globe is more general ; for it hath relation to all people living between the Equinoxial and either of the Poles : and according as the Poles of the Glob: are elevated or depressed , accordingly are the people said to be situate : Thus if the Globe be placed in the Frame of the Horizon so that the Pole be elevated 10 degrees above the Horizon ; then is the Globe elevated or fitted to resolve such Questions or Problems Astronomical as relate to those people who (have the Pole elevated, or) do live in the Latitude of 10 degrees.

This position of the Globe or Sphere is called *Oblique*, because the Axis of the World, the Equinoxial, and all the rest of the Parallels of Declination, are cut by the Horizon at Oblique Angles, whereas in the two former positions they cut one

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the other at Right Angles. Now the people which live in these middle Latitudes, (I mean between the *Arctic* and *Antarctic* Circles) which yet to our knowledge is the most habitable part of the world, do see Stars both of the Northern and Southern Hemispheres; but yet they see not all the Stars in either Hemisphere; for in any Oblique Latitude, the inhabitants see, and may observe all such Stars that are of the contrary Hemisphere to them, whose declinations are lesser than the complement of their Latitude; and all

Pl. 27.



Hours, Days, Weeks, Months, and Years.

Of a Year.

A Year, though it might have been as truly said of any other Star or Planet, is now made proper to the *Sun* or *Moon*, whose Revolution in the *Ecliptick* is the general definition of this part of Time; so that every Month, in the stricter sense, should be taken for a Lunar Year.

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Of Time.

Time is the measure of all our motions, and is divided by the two greater Lights of Heaven, into *Hours, Days, Weeks, Months, and Years.*

Of a Year.

A Year, though it might have been as truly said of any other Star or Planet, is now made proper to the *Sun* or *Moon*, whose Revolution in the *Ecliptick* is the general definition of this part of Time; so that every Month, in the stricter sense, should be taken for a Lunar Year.

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Of a Lunar Year.

The *Lunar Year* is that space of time wherein the *Moon* measureth the *Zodiack* Twelve times, or maketh Twelve Conjunctions with the *Sun*, which she finisheth in the space of 354 days, 8 hours, and some odde minutes, 11 days or thereabouts before the *Sun*.

Of the Sun's Year.

The *Sun's Year* is the Revolution of his motion in the *Heliptick*; which if it be accounted in the *Zodiack*, was called *Annus Temporalis*, because it distinguished the four Times or Seasons of the year. 'Tis otherwise called *Annus Tropicus*, because the Astronomers of old reckoned this Year from the Tropicks. But if the Revolution of the *Sun* be accounted from any Fixed Star to the same again, the Year is then called *Annus Syderens*.

The precise quantity of this Year is determined of all to be 365 days: but the surplus of hours and minutes hath very much and vainly exercised the most Curious.

Julius Caesar looking upon it as a matter no way below his great consideration, after consultation with several Mathematicians, allotted 365 days and 6 hours for this Revolution, reserving every year the 6 odde hours to make a day for the *Bis-sextile* or Leap-year, being every fourth in order; so that the three first years should consist of 365 days, and the fourth of 366; which by infallible experience is found too much. For the motion of the

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the *Sun* through the *Zodiack*, from one fixed point to the same again, according to more exact Computation, is determined to consist of 365 days, 5 hours, 49 minutes, and 4 seconds; which falls short of 6 hours by 10 minutes and 56 seconds in every year; which must of necessity breed a difference of so many minutes and seconds every year betwixt the Year which the *Sun* describes in the *Zodiack*, and that which is reckoned upon in the *Kalendar*.

Hence it comes to pass, that the *Vernal Equinox*, which in the *Emperour's* time fell out to be upon the 24 of *March*, now falls about the 11 of *March*, twelve days backward, and more; so that if it be let alone, it will get back to the first of *March*, and so to *February*, till *Easter* falls to be upon *Christmas-day*, which ought also to anticipate the 25 of *December* in our common *Julian year*, and be celebrated about thirteen days sooner.

Therefore the *Pontificians* do, according to the *Gregorian Emendation*, precede us by ten days in their account, which is called *The New Stile*. But why they went no higher than the *Nicene Council* in the Correction of the Year, and so fell short in the true time, the reason I must leave to them to give.

Of Civil and Natural days.

The *Civil day* is that space of time containing just 24 hours, reckoned from 12 of the clock on one day, to 12 of the clock the next day; in which space of time the *Equinoxial* makes a diurnal revolution upon the *Poles* of the world.

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The *Natural day* is that space of Time wherein the *Sun* moveth from the Meridian of any place to the same Meridian again.

Of an Hour:

An *Hour* is the twenty fourth part of a day and a night; or the space of time that 15 degrees of the Equator takes up in the passing through the Meridian. For the whole Equator, which contains 360 degrees, passeth through the Meridian in 24 hours, which are Mathematically divided into minutes, seconds, thirds, &c.

Of the Zenith.

The *Zenith* (or *Senith* in the Arabick) is the Pole of the Horizon, an imaginary point just over our heads, viz. the Vertical point, or highest top-point of the Heaven from our Horizon, and equidistant from it round about 90 degrees.

Nadir.

The *Nadir*, or *Natbir*, a foot-point perpendicularly imagined from our feet down through the Centre of the Earth, is that point in Heaven which is directly under our feet.

See

Geographical Definitions.

A Description of the Circles, Lines, &c.

Drawn upon the Superficies of the

Terrestrial GLOBE.

Of the Equator.

THE *Equator*, or the Line under the Equinoxial, is a great Circle encompassing the very middle of the Globe between the two Poles, dividing it into two equal parts from North to South, and is divided, as the Equinoxial, into 360 equal parts or degrees, and is called *The Equator*, either because it is equally distant from the Poles of the World, or rather because when the *Sun* comes to this Line, which is twice in a year, viz. in the beginning of *Aries*, which with us is about the 10 and 11 of *March*, and again in *Libra*, which is about the 13 and 14 of *September*, he makes equality of days and nights throughout the world.

Of the Meridians.

The *Meridians* are Circles passing through the Poles of the Globe, and cut the Equator at Right Angles;

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Angles : infinite in number, because all places from East to West have several Meridians ; but the number of Meridians delineated upon our Globes are 24. The first or chief Meridian, which is as it were the Land-mark of the whole Earth in our new Globes, begins at the Island of S. Michael, one of the Isles of the *Azores* ; from whence is reckoned the beginning of Longitude, and is the onely Circle passing through the Poles of the Globe ; which is divided into twice 90 degrees, numbred from the Equator towards both the Poles. The lesser Meridians are those black Circles which pass through the Poles of the Globe, succeeding the great Meridian at 10 and 10 deg. in most Globes ; but in ours at 15 and 15 degrees difference, and are numbred in the Equator with 15 30 &c. to 360, round the Globe.

Of the Parallels.

The *Parallels* are Circles running East and West round about the Globe like as the Equator ; onely the Equator is a great Circle, and these are every one less than the other, diminishing gradually, until they terminate and end in the Pole. As the Meridians are infinite, so are the Parallels, and are delineated through every tenth degree of the first Meridian, numbred from the Equator to either of the Poles with 10 20 to 90.

Of the Lines under the Ecliptick, Tropicks, and Polar Circles.

Crossing the Equator obliquely in the middle is the Ecliptick : the utmost extent of it towards the

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the North, noteth out the Tropick of *Cancer*; towards the South, the Tropick of *Capricorn*; each of them distant from the Equator 23 degrees and a half. Parallel to the Tropicks, and at the same distance from the Poles as they are from the Equator, are drawn the *Arctic* and *Antarctic* Circles; offering themselves to sight by their Names, and distinctions of Breadth and Colour; being, as the Tropicks are, represented by more full Lines than the Parallels are.

ADVERTISEMENT.

AS for the Land, Seas, Islands, Rivers, Ruins, with other Geographical Definitions relating to the Terrestrial Globe; I shall refer you to my following Description of Universal Maps and Charts; wherein is fully and methodically explained the whole Rudiments of Geography; being very necessary for the better illustration and understanding of the Terrestrial Globe;

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Having

Astronomical Definitions;

Having thus given you a brief Account of the several Positions of the Globe or Sphere, and of the Explanations of the Lines, Circles, &c. it will be convenient now to shew you the Uses thereof in the Solution of Problems of divers Kinds: in the performance whereof, I shall be both brief and plain.

And whereas I formerly said, that divers Problems may be resolved upon either Globe, it being in any position whatsoever (which will plainly appear hereafter) yet it will be more convenient to have the Globe fitted and accommodated with all its necessary Appendants before you make use of it. And therefore my first business shall be, to shew how to fix and set the parts of the Globe together, fit for use in any assigned Latitude or part of the World: and this I call *Rectifying of the Globe.*

How to Rectifie the GLOBES,

sitting them for Use

In any LATITUDE

or place of the World.

BEING provided of a pair of Globes, the Meridian, Horizon and Hour-circle truly turned and divided; also the Ball truly hung, and the Meridian and Horizon (in all positions) cutting each other at Right Angles, the Papers truly joynted in their Passing, &c. all which are to be performed by the Work-man, (though the Buyer ought also to have inspection therein) you may proceed to Rectifie them in this manner.

1. Put the Brass-Meridian into the two Notches that are in the North and South-parts of the Horizon; the Graduated or divided part thereof towards the East-point, and the blank or plain side of the Meridian towards the West-point of the Horizon; and let the Meridian rest in the Notch which is in the foot or bottom of the Horizon.

2. Place the Hour-wheel about the Pole, so that the Hour-lines of 12 and 12 do lie directly over the East or Graduated side of the Meridian, and that the point of the Axis do pass directly through the Centre of the Hour-circle; so shall the two Twelves, one of them represent 12 at

D 2

Noon

Noon, and the other 12 at Midnight; and the two Sixes, the one 6 in the Morning, and the other 6 at Night. Then put the little Index or Pointer upon the Axis, so that it may move as you turn the Globe about; and so is your Hour-wheel Rectified.

4. Elevate the Pole of your Globe (whether the North or South-pole) according to the Latitude of that part of the world you are in: as for Example, for London, whose Latitude is 51 deg. 30 min. North; the Meridian being in the Notches of the Horizon, and also in that in the foot of the Frame, as is before directed, Move the Meridian up or down in the Notches, till you finde 51 deg. 30 min. of the Meridian justly to touch the upper part of the North-part of the Horizon: for then is your Globe set exactly to the Latitude of 51 deg. 30 m.

4. For the Rectifying of the Quadrant of Altitude, this also must have respect to the Latitude: Wherefore, the Latitude being 51 deg. 30 min. count 51 deg. 30 min. upon the South-part of the Meridian, from the Equinoxial-circle towards the North (or elevated) Pole; and put on the Nut which is at the end of the Quadrant, so that the edge of the divisions of the Quadrant may lie distinctly under the degrees of the Latitude, viz. under 51 deg. 30 min. and then screw the Nut fast; and so is the Quadrant of Altitude Rectified also.

These are the four principal things that almost in all Cases must be Rectified: for the Circle of position, that seldome comes in use but in Dialling and Astrologie; and so it is not fit to cumber the Globe with it at other times; but when there is occasion for it, you must rectifie it as followeth.

5. The two ends of the diameter of this Circle are to be placed in the North and South-points of the Horizon; and it is to move up and down between the Meridian and the Horizon, and there to be fixed or held at any acquired place. And this is all the Rectifying that this Circle requires, and is (as I said before) but seldome to be used; and therefore they are not usually made or sold with the Globes.

Astronomical Problems.

PROB. I.

The day of the Month known, either according to the Julian or Gregorian Account, to finde the Sun's place in the Ecliptick.

SEEK the day of the Month (in either Account) according as you finde them placed in the Kalendar, and right against it, in the innermost Circle next to it, you shall have the degree and minute in which the Sun shall be that day at noon.

EXAMPLE.

Let the day proposed be the 18 of *October* (in the *Julian*, or the 28 of *October* in the *Gregorian* Account) which is *S. Luke's* day: Finde this Month and Day in the Kalendar, and right against it (in the innermost Circle) you shall finde 5 deg. 32 min. of *Scorpio*, in which Signe and degree the Sun will be upon that 18 or 28 of *October*.

In like manner, upon the 24 of *April* (*Julian*) or the 4 of *May* (*Gregorian*) (which is all one day) the Sun will be found to be in 14 deg. 32 min. of *Taurus*. And so of any other day, as in the following Table, which sheweth, that upon

	Jul.	Greg		d.	m.	
January	7	17	The Sun's place at Noon will be in	28	9	Capricorn ♑
February	12	22		4	38	Pisces ♓
March	23	Apr 3		13	23	Aries ♈
May	16	26		5	39	Gemini ♊
July	27	Aug. 7		14	16	Leo ♌
September	3	13		21	0	Virgo ♍
November	5	15		23	41	Scorpio ♏

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PROB. II.

By knowing the Place of the Sun in the Ecliptick, the day of the Month in either of the Accounts may be obtained: As followeth.

Seek the signe, degree and minute in which the Sun is, in the innermost Circle of the Horizon; and right against it, you shall have the day of the month in both Accounts.

EXAMPLE.

Let the Sun be in 24 deg. of Gemini; look in the innermost Circle for the signe Gemini, and against it in the Kalendar you shall finde the 4 of June (Julian) or the 14 of June (Gregorian) which is the day of the month.

In like manner, when the Sun is in 14 deg. 53 min. of Capricorn, the day of the month will be found the 25 of December (Julian) or the 4 of January (Gregorian.)

PROB. III.

The Latitude (51 deg. 30 min.) and the Sun's place in the Ecliptick (viz. in 29 of Taurus) being given, to finde

The Sun's Declination.

Definition] The Sun's Declination is an Arch of the Meridian, comprehended between the Equinoctial

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Equinoxial Circle, and that point of the Ecliptick in which the Sun is.

Practice.] Bring the 29 deg. of *Taurus* to the Brass-Meridian; then shall the degrees of the Meridian contained between the Equinoxial and this point, be 20. So that the declination of the *Sun* is 20 deg. North, because the *Sun* is in a Northern Signe.

In like manner,

	deg. min.		deg. min.
When the <i>Sun</i> is in deg.	$\left. \begin{array}{l} 16^{\circ} 00' \gamma \\ 25^{\circ} 00' m \\ 29^{\circ} 00' \infty \\ 13^{\circ} 00' \Omega \end{array} \right\}$	The <i>Sun's</i> declination will be found to be	$\left\{ \begin{array}{l} 15^{\circ} 46' \text{ North.} \\ 19^{\circ} 05' \text{ South.} \\ 11^{\circ} 32' \text{ South.} \\ 5^{\circ} 9' \text{ North.} \end{array} \right.$

PROB. IV.

The Sun's Amplitude.

Defini- **T** *He Amplitude, is an Arch of the Horizon comprehended between the East or West-points thereof, and that point upon which the Sun doth Rise or Set.*

Practice.] Bring 29 deg. of *Taurus* to the Horizon, and there you shall finde 33 deg. 20 min. to be contained between that, and the East or West-point, towards the North, because the *Sun* is in a Northern signe, that is very neer the North-East by East point of the Compass, as appears by the points upon the Horizon: and that is the Amplitude.

An in like minner,

	d. m.		d. m.
When \odot is in deg.	$\left\{ \begin{array}{l} 16^{\circ} 00' \Omega \\ 25^{\circ} 00' m \\ 29^{\circ} 00' \infty \\ 13^{\circ} 00' \gamma \end{array} \right\}$	The <i>Sun's</i> Amplitude will be from the East or West found	$\left\{ \begin{array}{l} 26^{\circ} 28' \text{ Northward} \\ 31^{\circ} 41' \text{ Southward} \\ 19^{\circ} 17' \text{ Southward} \\ 7^{\circ} 34' \text{ Northward} \end{array} \right.$

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PROB. V.

The Sun's Right Ascension.

Defini- **T**He Right Ascension of the Sun or of a
tion] Star, is that Arch of the Equinoxial
which is contained between the beginning of Aries,
and that point of the Equinoxial which comes to the
Meridian, with that point of the Ecliptick in which
the Sun or Star is.

Practice.] Bring the 29 deg. of *Taurus* to the
Meridian; so shall you finde (upon the Equino-
xial) 56 deg. 50 min. to be contained between the
beginning of *Aries* and the Meridian: And such is
the Sun's Right Ascension when he is 29 deg. of
Taurus.

In like manner,

	deg. min.		deg. min.
When the Sun	16 00 Ω	{ The Sun's Right Af- cension will be }	138 26
is in deg.	25 00 \mathcal{M}		232 38
	29 03 ∞		330 51
	13 00 γ		11 57

PROB. VI.

The Oblique Ascension.

Defini- **T**He Oblique Ascension of the Sun, or of a
tion.] Star, is that Arch of the Equinoxial
which is comprehended between the beginning of Aries
and that point of the Equinoxial which comes to the
East-point of the Horizon, with that point of the E-
cliptick in which the Sun or Star is.

Practice.] Bring 29 degr. of *Taurus* to the East-
side

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side or semicircle of the Horizon, then shall you finde 20 deg. 30 min. of the Equinoxial to be contained between the beginning of *Aries* and the East-point of the Horizon; and that is the Oblique Ascension of the *Sun* or Star, it being in the 29 degree of *Taurus*.

In the same manner,

	deg. min.		deg. min.
The <i>Sun</i> being in	16 00 Ω	The Oblique Ascension	117 10
	25 00 \mathcal{M}	will be found to be	258 27
	29 00 \equiv		346 30
	13 00 γ		003 06

P R O B. VII.

To finde the Ascensional Difference.

Defini- **T**He difference of Ascension is no other
tion] than the difference of degrees between
the Right and Oblique Ascension. Wherefore subtract the lesser from the greater, and the remainder will be the Ascensional Difference, which will be found to be 17 deg. 14 min. Or, the Ascensional difference is that space of time contained between 6 of the clock either in the morning or the evening, and the time of the *Sun*'s Rising or Setting. Wherefore,

P R O B. VIII.

To finde the time of the Sun's Rising and Setting.

Practice.] **B**Ring 29 deg. of *Taurus* to the Meridian, and set the Index of the Hour-wheel to 12 of the clock Southward: then turn the

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the body of the Globe Eastward, till 29 deg. of *Taurus* touch the East-side of the Horizon; and then with the Index of the Hour-wheel point out 11 min. after 4 in the morning, at which time the *Sun* Riset, And if you turn the body of the Globe about Westward, till the 29 deg. of *Taurus* doth touch the West-side of the Horizon, then shall the Index of the Hour-circle point at 49 min. after 7 at night, at which time the *Sun* Setteth.

PROB. IX.

To finde the Length of the Day and Night.

Practice.] Turn the Globe about till 29 deg. of *Taurus* touch the East-side of the Horizon; and then set the Index of the Hour-circle to the North (or undermost) 12. Then turn the Globe Westward, till 29 deg. of *Taurus* touch the Horizon on the West-side, and then shall the Index of the Hour-wheel point at 3 hours 38 min. more than 12 hours. So that the day is then 15 hours and 38 min. long. And if you count the hours between the North 12 and the Hour-Index, you shall finde them to be 8 hours and 22 min. which is the length of the night, the *Sun* being in 29 deg. of *Taurus*.

And so,

		Ascens. diff.	Sun's rise	Sun's set	length of day	length of night
d. m.		d. m.	h. m.	h. m.	h. m.	h. m.
being in { 16.00 ♈	you'll finde {	21.12	4.35	7.25	14.50	9.12
{ 25.00 ♉		25.52	7.43	4.17	8.34	15.28
{ 29.00 ♊		15.00	7.00	5.00	10.00	14.00
{ 43.00 ♋		6.30	5.34	6.26	12.52	11. 8

PROB.

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PROB. X.

The Sun's Meridian-Altitude, and his depression at Midnight.

THis may be effected, by adding or subtracting of the *Sun's* Declination to or from the Complement of the Latitude : For,

Definit.] It is an Arch of the Meridian, comprehended between the intersection of the Meridian with the Horizon, and that part of the Meridian upon which the Sun is at Noon or Midnight.

Practice.] Turn the Globe about, till the 29 degree of *Taurus* be just under the Meridian; then shall you finde the number of degrees of the Meridian which are comprehended between that point and the Horizon to be 58 deg. 30 min. which is the Meridian-Altitude. And if you bring the 29 deg. of *Scorpio*, which is the opposite point of the Ecliptick in which the *Sun* is, to the Meridian, the number of the degrees of the Meridian between that point and the Horizon will be found to be 18 deg. 30 min. which is the *Sun's* depression at midnight.

In like manner,

	d. m.		d. m.		d. m.
When the	18 00 St.	You shall	54.36	& the	22.24
Sun is in	25.00 M.	finde the	19.25		57.25
	29.00 ☿	Meridian	26.38	depression	50.22
	13.00 ♀	Altitude	43.39		33.24

PROB.

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PROB. XI.

When the Twilight begins and ends.

Defini- **T**He *Twilight* beginneth when the *Sun* is
tion] 18 deg. below the *Horizon* before its
Rising, and it endeth when the *Sun* comes to be 18
deg. below the *Horizon* after its Setting.

Practice.] The *Globe Rectified*, and the *Sun* in
29 deg. of *Taurus*, finde the opposite point there-
unto, which is the 29 deg. of *Scorpio*; and bring
that point, as also the *Quadrant* of *Altitude*, both
of them on the West-side of the *Meridian*; and then
move both the body of the *Globe*, and the *Qua-*
drant of *Altitude* also; till the 29 deg. of *Scorpio*
lie directly under 18 deg. of the *Quadrant* of *Al-*
titude: which done, keep them both together, and
then see how many hours the *Index* is removed
from 12, which you shall finde to be 1 hour and
8 minutes. So that *Twilight* begins at 8 min. af-
ter 1 in the morning. And this being taken from
4 ho. 11 min. the time of the *Sun*'s Rising that
day, there will remain 3 ho. 3 min. which is the
length or continuance of the *Twilight*. Also if
you double the time of the beginning of *Twilight*
1 ho. 8 min. you shall have the length of dark
night, which will be but 2 ho. 16 min.

In like manner, if you would know when the
Twilight endeth after *Sun*-setting, you must bring
the 29 deg. of *Scorpio* (the point opposite to the
Sun) on the East-side of the *Meridian*, making it
and 18 deg. of the *Quadrant* of *Altitude* to meet,
then the *Index* will shew 10 hours 52 min. and
till

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till that time of night doth *Twilight* continue,
And so,

	deg.		ho. mi.		br. min.
The Sun in	29 5	Day-break will be at	0.10	alt. midnigh	11.50
	8 7		5.52		6. 8
	2 12		4. 6		7.54
	0 8		2.41		9.19
					at night.

And if you go about to finde the time of the beginning and end of *Twilight*; all the time that the Sun is passing from 2 deg. of *Gemini* to 30 deg. of *Cancer*, which is from about the 12 of *May* to the 12 of *July*, you shall finde that there will be no *Twilight* at all, but all that time continual day, for all that space of time the Sun never descendeth so much as 18 deg. under the Horizon, in the Latitude of 51 deg. 30 min.

P R O B. XII.

What Altitude the Sun shall have at 6 of the Clock in the morning or evening.

Defini- **T**He Altitude of the Sun, or of a Star, &c. tion] is an Arch of an Azimuth or Vertical Circle, passing through the Zenith and Nadir points and the body of the Sun or Star, counted from the Horizon to the Sun or Star: and all such Azimuths or Vertical Circles are represented by the Quadrant of Altitude.

Note, that this Problem is onely in use when the Sun is in the six Northern signes: for the Sun is never above the Horizon at six, when he is in Southern signes.

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Practice.] Bring the 29 deg. of *Taurus* to the Meridian, and set the Index of the Hour-circle to 12; then turn the Globe about Eastward, till the Index of the Hour-circle come just to 6 a clock; then holding the Globe there, lay the Quadrant of Altitude just over the 29 deg. of *Taurus*, and there you shall finde it to cut 15 deg. 30 min. of the Quadrant. And such *Altitude* shall the *Sun* have at 6 of the clock in the morning, and the same at 6 at night.

And so,

	deg. min.		deg. min.
When the <i>Sun</i> is in	16.00 Ω	The <i>Sun</i> 's <i>Altitude</i> at 6 will	12.32
	13.00 γ	be found to be	4.2

PROB. XIII.

What Azimuth the Sun shall have at 8 of the Clock.

Defini- **T**He Azimuth is an Arch of the Horizon *edition*] comprehended between the East, West, North or South points thereof; and the intersection of a Vertical Circle passing through the Sun or Star whose Azimuth you seek.

Note, this Problem is of Use onely when the *Sun* is in Northern signes.

Practice.] Bring the 29 of *Taurus* to the Meridian, and set the Index of the Hour-wheel to 12; then move the Globe till the Index lie upon 6; and holding the Globe there, lay the Quadrant of Altitude just over 29 deg. *Taurus*; then shall you finde, that there are 77 deg. 14 min. of the Horizon

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zon contained between the intersection of the North-part of the Meridian; and the Quadrant of Altitude, which is the Azimuth from the North: or 12 deg. 46 min. from the East, which is the Azimuth from the East: or 102 deg. 46 min. from the South, which is its Azimuth therefrom.

In like manner,

	d.m.		d.m.	d.m.	d.m.
16.0	Ω	The Sun's Azimuth at 6 will be found to be from the	North	East or west	South
13.0	γ		79.49	104.11	100.11
			86.47	3.13	93.13

PROB. XIV.

At what hour the Sun shall be upon the East or West Azimuths.

☐ This Problem is onely of use when the Sun is in Northern signes.

Practice. **B**Ring the 39 deg. of *Taurus* to the Meridian, and the Index to 12 of the Clock. Also bring the beginning of the degrees of the Quadrant of Altitude to the East-point of the Horizon, and turn the Globe about till the 29 degree of *Taurus* do touch the degrees of the Quadrant of Altitude; then shall the Index point at 7 min. past 7, at which time in the morning will the Sun be exactly upon the East Azimuth, or point of the Compass. And if you carry the Quadrant of Altitude to the West-point of the Horizon, and turn the Globe about till 29 deg. of *Taurus*

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Taurus touch the edge of degrees thereof, the Hour-Index will point at 4 of the clock and 53 min. at which time in the afternoon will the *Sun* be upon the West-Azimuth or point of the Compass.

In the same manner,

	d. m.	d. m.	d. m.
When the	16.00	It will	6.59
<i>Sun</i> is in	13.00	be due	5.03
		East at	6.17
		West at	5.43

PROB. XV.

What Altitude the *Sun* shall have when he is upon the East or West-Azimuths.

☛ This Problem is in use onely when the *Sun* is in Northern signes,

Practice. Ring 29 deg. of *Taurus* to the Meridian, and the Quadrant of Altitude to the East or West-points of the Horizon: Then turn the Globe about, till the 29 deg. of *Taurus* touch the Quadrant of Altitude, and you shall finde it to abut at 25 deg. 55 min. of the Quadrant: and such Altitude hath the *Sun*, when he is upon the East or West-Azimuth.

In like manner,

	d. m.	d. m.
When the	16.00	Its Altitude when
<i>Sun</i> is in	13.00	East or West will
		be found
		20.19
		6.36

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PROB.

PROB. XVI.

What Altitude the Sun shall have at any time of the day.

Practice.] Bring 29 deg. of *Taurus* to the Meridian, and set the Hour-Index to 12 a clock. Then turn about the Globe till the Hour-Index point to the given hour (suppose 9 in the morning, or 3 in the afternoon :) there keep the Globe; and laying the Quadrant of Altitude over the 29 deg. of *Taurus*, you shall finde 43 deg. cut thereby; and such Altitude shall the *Sun* have at 9 in the morning, or 3 in the afternoon. And by this Problem the *Sun*'s Altitudes in any signe or degree of the Ecliptick at all hours may be found; as in this following *Synopsis* or Table.

So the Sun being in the beginning of	Cancer	Gemin. or Leo.	Taurus or Virgo.	Aries or Libra.	Scorpio or Pisces.	Aquar. or Sagitt.	Capric.
At the ho.	d.m.	d.m.	d.m.	d.m.	d.m.	d.m.	d.m.
XII. 7	62 00	58 42	50 00	38 30	27 18	18 18	15 00
XI. I.	59 43	56 34	48 12	36 58	25 40	17 6	13 48
X. II.	53 45	50 55	43 12	32 37	21 51	13 38	10 30
IX. III.	45 42	43 5	36 0	26 7	15 58	8 12	5 26
VIII. IV.	36 41	34 13	27 31	18 8	8 33	1 15	
VII. V.	27 17	24 56	18 18	9 17	0 6		
VI.	18 11	15 40	9 0				
V. VII.	9 32	6 50					
IV. VIII.	1 32						

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This Table will be of good use to such as have occasion to make *Cylinders* or *Quadrants*, to finde the hour of the day ; or *Rings* and other *Instrumental Dyals* ; and to insert the *Tropicks* and other *Parallels* of the *Sun's* course in fixed *Sun-Dyals*, &c.

PROB. XVII.

What Altitude the Sun shall have, he being upon any Azimuth.

Practice.] **S**Et the Quadrant of *Altitude* to the *Azimuth* you intend to finde the *Altitude* upon ; (suppose the 30 deg. of *Azimuth* from the South towards the East :) bring the Quadrant of *Altitude* thither ; and keeping of it there, turn the Globe about till 29 deg. of *Taurus* touch the degrees of the Quadrant of *Altitude*, and you shall finde them to concur at 55 deg. 34 min. of the Quadrant : and such is the *Sun's Altitude*, when he is 30 deg. from the South-part of the Meridian either Eastward or Westward. And by this means you may finde the *Azimuth* at all times. An Example of the *Sun's Altitude* upon every Tenth *Azimuth* from the South, in the beginning of each Signe, here followeth.

The Sun in the begin- ning of	Cancer or Gemini	Leo or Taurus	Virgo or Aries	Libra or Pisces	Scorpio or Aquar.	Sagitt or Capric
d. 27	d. m.	d. m.	d. m.	d. m.	d. m.	d. m.
0	62 0	58 42	50 0	38 30	27 0	28 18
10	61 43	58 24	49 38	38 4	26 30	17 45
20	60 51	57 28	48 33	36 46	25 10	16 5
30	59 52	55 52	46 40	34 34	22 27	13 15
40	57 20	53 29	43 51	31 21	18 48	9 14
50	54 35	50 12	40 11	27 5	13 58	3 57
60	49 56	45 53	35 23	21 41	8 6	
70	44 40	40 25	29 27	15 13	1 0	
80	28 11	33 46	21 29	7 52		
90	30 38	26 10	14 25			
100	22 27	18 02	6 45			
110	14 14	9 58				
120	6 34	2 30				

This Table hath the like use for the making of
Cylinders, Quadrants, and other Instruments that
give the Azimuth by the height of the Sun, as the
preceding Table hath for the Hour, and may be so
applied.

When he is going from the South-part of the
Meridian either Eastward or Westward. And by
the means you may find the Azimuth at all times.
An Example of the Sun's Azimuth upon 27.7.
To find what way from the South, in the beginning
of each Sign, here followeth.

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The Latitude (51 deg. 30 min.)
the Sun's place in the Ecliptick,
(29 deg. 0 min. of *Taurus*) and
his Altitude (12 deg.) being
given : To finde

PROB. XVIII.

The Sun's Azimuth at any time.

Practice.] **T**HE Globe being Rectified, &c. and
the *Quadrant of Altitude* fixed, and
brought to the *Horizon* ; Turn 29 deg. of *Taurus*
toward the East, if in the morning ; or towards the
West, if in the evening, till it come to lie just under
deg. of the *Quadrant of Altitude* ; and then note
at what degree in the *Horizon* the *Quadrant of*
Altitude resteth ; which will be at 16 deg. 8 min.
from the East if in the morning, or 16 deg. 8 min.
from the West if in the afternoon Northward,
which is the *Azimuth* from the East or West to-
wards the North. And this *Azimuth*, if reckon-
ed by the Points of the Compass upon the *Hori-*
zon, will be E. by N. 4 deg. 53 min. Northward,
if in the morning ; or W. by N. 4 deg. 53 min.
Northward, if in the evening, when the *Sun* is in
29 deg. of *Taurus*, and hath 12 deg. of *Altitude*.
Now if you count the degrees of the *Horizon* be-
tween the *Quadrant of Altitude* and the North-
part of the *Meridian*, you shall finde them to be
73 deg. 52 min. which is the *Azimuth* from the

E 3

North :

Astronomical Problems.

North : And if you count them from the South-part of the *Meridian*, you shall finde them to be 106 deg. 8 min. which is the *Azimuth* from the South.

In like manner,

	<i>deg. min.</i>
The Latitude being	51 30
The <i>Sun's</i> place	1 00 <i>Aquarius</i>
The <i>Sun's</i> Altitude	12 00

Then will the *Azimuth* be found to be 56 deg. from the East or West towards the South ; which (by the Points of the Compass upon the *Horizon*) will appear to be S. E. by S. if in the morning, or S. W. by S. if in the evening.

PROB. XIX.

The Hour of the day.

Practice.] **B**Ring 29 deg. of *Taurus* to the *Meridian*, and set the Index to 12 o'clock : Then, if it be in the forenoon, set the *Quadrant of Altitude* on the East-side of the *Meridian*, but on the West-side, if it be in the afternoon. And turn the Globe about, till the 29 deg. of *Taurus* meet with 12 deg. of the *Quadrant of Altitude*, and then shall the Index of the Hour-circle point at 5 a clock and 36 min. if it be in the morning, or at 24 min. after 6 of the clock, if it be at night. And that is the true hour of the day.

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In like manner,

	deg.	min.
The Latitude being	51	30
The <i>Sun's</i> place	1	00 <i>Taurus.</i>
The Altitude	36	00

Then will the hour of the day be found to be either 9 in the morning, or 3 in the afternoon. And which of these hours it is, may best be known by a second observation of the *Altitude*: for if the *Altitude* do increase, it is the forenoon; but if it decrease, it is the afternoon.

Again,

	deg.	min.
The Latitude being	52	30
The <i>Sun's</i> place the beginning of <i>Taurus.</i>		
The <i>Sun's</i> Altitude	25	56

The hour of the day would be found to be either 8 min. past 4 in the afternoon, Or if it were in the forenoon, 52 min. after 7 in the morning.

PROB. XX.

To find the Difference of Latitude, or, to know how many degrees the Pole must be Elevated or Depressed, to make the Longest day in any Latitude an Hour longer, or the Shortest an Hour shorter than it is in your Latitude.

L Et it be required to finde in what Latitude the Longest day shall be an hour longer than it is at London.

E 4

Pro

Practice.] Rectifie the Globe to the Meridian of *London*, the Index of the Hour-circle to 12, and the Solstitial Colure to the Meridian; so shall the number of hours contained between the Brass-Meridian and the Horizon, upon the Tropick of *Cancer*, be half the length of the *Longest day* at *London*, namely, 123 deg. which in time is 8 ho. and 13 minutes for the *Semidecimal Arch* of the *Artificial day* at *London*. At this intersection of the Tropick of *Cancer* with the Horizon, make a small mark upon the Tropick, and move the Globe Westward, till the Equinoxial Circle hath passed 7 deg. 30 min. or one half hour of time from the Meridian; and then observe where the Tropick of *Cancer* intersects with the Horizon again, and there upon the Tropick make another small mark. Then bring the Solstitial Colure back again to the Meridian, and there fix the Ball of the Globe; and move the Brass-Meridian in the Horizon upwards, till your second prick which you made upon the Tropick do just touch the Horizon; then will the Globe stand at that Latitude in which the *Longest day* will be an hour longer than the *Longest day* at *London* is; and that Latitude will be found to be 56 deg. 27 min.

But if you would know in what Latitude the *Longest day* shall be one hour shorter than at *London*, then having made a mark upon the Tropick at the termination of the *Longest day* there, move the Globe Eastward, till 7 deg. 30 min. have passed the Meridian; and where the Tropick and Horizon intersect, make there a mark upon the Tropick, and bring the Solstitial Colure to the Meridian, and fix the body of the Globe there: then de-

press the Meridian in the Horizon, till your second mark do touch the Horizon; then will the Globe rest at that Latitude wherein the Longest day will be one hour shorter than the Longest day at London is: which Latitude will be found to be 35 deg. 58 min.

PROB. XXI.

How much must the Sun's Declination increase or decrease, to make the Day Artificial one hour longer or shorter than it was at the time proposed.

Suppose in Latitude 51 deg. 30 min. the Sun to have 10 degrees of North-Declination, and I would know how much the Declination must increase Northward, to make the day one hour longer than it is.

Practice.] Elevate the Globe to the Latitude of London, 51 deg. 30 min. and bring the Equinoxial Colure to the Meridian, and bring the Sun's place, or the parallel of 10 deg. his Declination, to the Horizon; and upon the Horizon make a small mark, to which bring the Equinoxial Colure, and at this intersection make a mark upon the Colure. Then (if the days lengthen, move the Globe Eastward, or Westward if they shorten) till 7 deg. 30 min. of the Equinoxial have passed the Meridian; and then, again, where the former Colure intersects with the Horizon, make another mark, upon the Colure. This done, bring the Colure to the Meridian again, and see what number of degrees

degrees of the Meridian (or degrees of the Colure it self) are contained between the two pricks; which you shall finde to be 4 deg. and 40 min. And so much must the Declination increase Northward, to make the day lengthen one hour, at that time of the year.

PROB. XXII.

To finde what number of days are contained between the days of Lengthening or shortning one hour, at any time of the year.

L Et the time be as in the last Example, where the *Sun* hath 10 deg. of North-declination; which will be about the 5 of *April*.

Practice.] Having made two pricks in the Colure, as in the last Example, Bring the first prick to the Horizon, where you shall finde it to stand against the 5 of *April*. Then move the Globe till the other prick touch the Horizon; which it will do about the 19 of *April*, at which time the day will be one hour longer than it was upon the 5 of *April*: between which two days, there are contained 13 compleat days, and parts of both the two other days. So that you may conclude, that in 14 days time (at that season of the year) the days do lengthen one hour, and shorten as much when the *Sun* is in opposite signes.

PROB.

PROB. XXIII.

To finde the length of the Longest or Shortest day in any Latitude.

Defini- **T**He Longest Artificial day in any Latitude, is made by the Sun's passing thorow the Tropick of Cancer in all places that have North-Latitude, or thorow the Tropick of Capricorn to all that have South-Latitude.

Practise.] To finde the length of the Longest day at London, in Latitude 51 deg. 30 min. elevate the Globe thereto, and bring the Solstitial Colure to the Meridian, and the Hour-Index to 12. Then, count the number of hours upon the Tropick of Cancer, that are contained thereupon between the interfection thereof with the Horizon, on the East-side, and its interfection on the West-side; which you will finde to be 16 hours, and almost half an hour, viz. 26 min. for the length of the Longest day. And the number of hours contained between the East and West interfections of the Tropick of Capricorn and the Horizon, is the length of the Shortest day, which at London will be found to be 7 hours, and somewhat above half an hour, viz. 34 min.

Half the length of the Day is the time of the Sun's Setting, and half the length of the Night is the time of the Sun's Rising.

PROB.

PROB. XXIV.

*Of the Reason of the Inequality of Days
Natural, and Days Civil.*

Defini- **A** Natural day is that space of time in
tion.] which the Sun moveth from the Meri-
dian of some one place or Country, to the same Meridi-
an again. These days are not always of an equal
length, but are longer at some times of the year than
at other times, but at all times they are longer than
the Civil day is. A Civil day being that space of
time containing just 24 hours, reckoned from 12 a
clock one day, unto 12 of the clock the next day; in
which time the Equinoctial maketh one entire Revolu-
tion about the Axis of the world. The difference
between these two sorts of Days is but small; and
there is a double cause for this small inequality.

1. Because the Sun's apparent motion differs from
his true motion, as being slower when he is in his A-
pogæum, than in his Perigæum; he moving scarce
58 min. in a day when he is in the one, and above 61
min. when he is in the other; and so increaseth in
Right Ascension.

2. The difference of Right Ascensions in several e-
qual parts of the Ecliptick: for when the Sun is
neer either of the Tropicks, the Ascensional Differen-
ces are greater than when the Sun is about the Equi-
noctial: for about Aries or Libra, the Right Ascension
of 10 deg. is but 9 deg. 10 min. whereas the Right
Ascension of 10 deg. of Cancer or Capricorn is 10
deg. and 53 min.

Now this difference being so small, in one days
time

time it is not perceptible by the Globe: wherefore if you would finde this difference, it would be requisite to take some number of days, as 10, 20, or 30, and in them it will be apparent. And to effect it by the Globe, do thus: *Method* [*Practice*] First, finde the place of the Sun, both at the beginning and ending of those days you would compute the difference of. 2. Finde the Right Ascensions answerable to each place in the Ecliptick, as also the difference of Right Ascensions answerable to the motion of the Sun in each respective number of days. 3. Compare the difference of the Right Ascensions together, by subtracting the lesser from the greater, and the difference converted into time, shall be the number of minutes that the one number of days exceedeth the other.

EXAMPLE.

Let it be required to finde what difference there is in the length of the first 20 days of December, and the first 20 days of March.

	d.m.	d.m.	d.m.	d.m.
Decemb.	1 5 20.07	259.01	22.24	
	21 0 10.33	289.25		
March	11 21.24	349.26	18.22	
	21 11.11	10.28		
		Differ of ascens.	4.02	

Here by this Synopsis you may perceive that the difference of these 20 days taken at several times of the year is 4 deg. 2 min. which converted into time is 16 minutes, that is, a quarter of an hour and

and one minute ; and so much longer are the first 20 days in *December*, than the first 20 days of *March*.

And by this means you shall finde that the Month of *January* is longer than the Month of *June* (both Months consisting of 31 days) by 1 deg. 20 min. which is onely $4\frac{1}{2}$ min. in time.

		d.m.		d. m.	d.m.	d.m.
Sun's place	<i>January</i>	1	☐ 21.47	Its Right Ascens.	293.29	31.34
		31	☐ 22.17		324.53	
					Differ. of Ascens.	
						61.24
	<i>June</i>	1	☐ 20.40	Its Right Ascens.	79.43	30.04
		31	☐ 18.16		109.47	

Thus the Month of *January* is longer than the Month of *June* by 4 minutes and $\frac{1}{2}$ of a minute of time.

☐ All the fore-mentioned Problems may be performed upon either Globe ; the *Horizon*, *Meridian*, *Quadrant of Altitude*, *Hour-circle*, and most of the Circles upon the Globes themselves, being in both Globes the same. But it is most proper to use the *Terrestrial Globe* for *Geographical* and *Nautical Problems* ; and the *Celestial Globe* for such as concern *Astronomy* : and these following are chiefly such, and therefore best to be wrought by the *Celestial Globe*.

PROB.

PROB. XXV.

To finde the Longitude and Latitude of any Star.

Definition.] The Longitude of a Star is an Arch of the Ecliptick, contained between the beginning of Aries, and the intersection of an arch of a great Circle, which passeth through both the Poles of the Ecliptick, and also through the body of that Star.

The Latitude of a Star is that part of an arch of a great Circle which passeth through both the Poles of the Ecliptick, and through the bodie of the Star, and is contained between the Ecliptick-line and that Star.

Practice.] For the Longitude, skrew the Quadrant of Altitude over that Pole of the Ecliptick which is nearest to the Star whose Longitude you seek. Then laying the Quadrant just over the centre of the Star, look what degrees of the Ecliptick, (counting them from the beginning of Aries) and those degrees are the degrees of the Star's Longitude. So the Quadrant of Altitude skrewed over the North-pole of the Ecliptick, and laid upon the bright Star Capella, the Quadrant shall cut 77 deg. 16 min. of the Ecliptick-Circle, counted from the beginning of Aries; and that is that Star's Longitude.

Note, that the Poles of the Ecliptick are distant from the Poles of the world 23½ deg. on either side.

For

For the *Latitude*, the *Quadrant* fitted as before, and laid over the centre of *Capella*, the Star shall cut 25 deg. 50 min. of the *Quadrant* of *Altitude*, and such is the *Latitude* of that Star, North, for that it lies on the North-side of the *Ecliptick-Line*.

P. R. O. B. XXV.

To finde the *Right Ascension* and *Declination* of a Star.

Defini- **T**HE *Right Ascension* of a Star is that *tion* Arch of the *Equinoxial* which is contained between the beginning of *Aries* and that point which comes to the *Meridian* with that Star.

The *Declination* of a Star is an Arch of the *Meridian* contained between the *Equinoxial* and any Star.

Practice. For the *Right Ascension*, (the *Globe* being rectified) bring *Capella* to the *Meridian*, and then shall you finde 73 deg. 7 min. of the *Equinoxial* contained between the beginning of *Aries* and the *Meridian*; and that is the *Right Ascension* of *Capella*.

For the *Declination*, bring *Capella* to the *Meridian*, so shall you finde 45 deg. 37 min. of the *Meridian* contained between the *Equinoxial* and *Capella*; and that is the *Declination* of that Star. And in this manner you may finde the *Longitude*, *Latitude*, *Right Ascension*, and *Declination* of any other Star upon the *Celestial Globe*; As in the following Table of the principal Fixed Stars of the first Magnitude, you shall finde

Artis

Stars names.	Longit.		Latit.		R. Asc.		Decl.	
	d.	m.	d.		d.	m.	d.	m.
Arcturus	119.39		31.2	B	210.13		20.58	B
Lucida Lyræ	280.43		61.47	B	276.27		38.30	B
Algol	51.37		22.22	B	41.46		39.39	B
Capella	77.16		22.50	B	73.7		45.37	B
Aldebaran	65.12		5.31	A	64.17		15.48	B
Regulus	145.17		0.26	B	147.43		13.33	B
Gamma Leonis	167.3		12.18	B	173.4		16.25	B
Spica Virgin.	199.16		1.59	A	196.56		9.31	A
Antares	245.13		4.27	A	242.23		25.37	A
Fomalant	329.11		21.00	A	339.46		31.17	A
Regel	72.17		11.11	A	74.44		8.37	A
Syrus	99.3		39.30	A	97.42		16.14	A
Procyon	111.18		15.57	A	110.34		6.3	B

PROB. XXVI.

To finde the distance of two Stars.

Practice.] IF the two Stars be both of them under the same Meridian, Bring them under the General (or Brals) Meridian, and see what degrees of the Meridian are contained between them, for that is their distance.

2. If they lie not under the same Meridian, but have the same declination, or lie in the same Parallet, Bring one of them to the Meridian, and see what degrees of the Equinoctial are cut thereby : then bring the other Star to the Meridian, and count what degrees of the Equinoctial are contained between

between the Meridian and the degrees before found, for that is the distance of those two Stars.

3. If the two Stars do neither lie under the same Meridian, nor in the same Parallel, Then lay the Quadrant of Altitude (it being loose) to both the Stars, and the degrees of the Quadrant contained between the two Stars is their distance. And if the Quadrant be too short, you may use the Circle of Position, or take their distance with a pair of Calope-Compasses, and measure their distance upon the Equinoctial, or any other great Circle.

Thus

The Right Shoulder of *Auriga*, and the Right Shoulder of *Orion*, being under the same Meridian, their distance will be found to be 37 deg. 30 min.

Also

Arcturus and the Lions Neck, being neer in the same Parallel, their distance will be found to be 57 degrees.

Likewise

Lyra the Harp, and *Marchad* in the Wing of *Pegasus*, will be found to be distant 63 degrees.

P R O B. XXVII.

To know what Stars will be upon the Meridian at any hour of the Night.

Practice. **T**He Sun being in 29 deg. of *Taurus*, what Stars will be upon the Meridian at 10 a clock and 12 min. at Night, bring

29 deg. of *Scorpio* (which is the opposite Signe to *Taurus*) to the Meridian, and set the Index of the Hour-Circle to 12. then turn the Globe about Westward till the Index point at 12 min. after 10 a clock, and there hold the Globe, and all those *Stars* which lie under the Brass Meridian are then upon the Meridian, of which *Arcturus* is the Chief.

P R O B. XXVIII.

To know what day in the year any Star shall be upon the Meridian at 12 a clock at Night.

Practice.] **B**Ring the *Star* to the Meridian, and mark what degree of the Ecliptick is just under the Meridian at the same time: Then finde that degree of the Ecliptick in the *Horizon*, and note what day of the year standeth against it; for that day of the year will that *Star* be upon the South-part of the Meridian at 12 at night: and when the Sun is in the opposite Point of the Ecliptick, the same *Star* will be upon the North-part of the Meridian at 12 at noon.

F 2

P R O B.

PROB. XXIX.

The Sun's Place, and the Altitude of a known Star given, To finde the hour of the Night.

THe *Sun* being in 21 deg. of *Capricorn*, the Altitude of the *Great Dog* 14 deg. I demand the hour of the Night.

Practice.] The Globe Rectified, &c. bring 21 deg. of *Capricorn* to the Meridian, and the Index to 12 a clock. Then move the Globe and Quadrant of Altitude so together, that the *Great Dog* meet with 14 deg. of the Quadrant; and then shall the Index point at 8 of the clock and 22 minutes; which is the true hour of the Night.

And thus

	deg.		d.	d.m.
When	20 7	and the	The Bulls eye 39	The ho 7.12
the Sun	20 11	Altitude of	The Bulls eye 30	will be 9. 2
is in	3 II		Arcturus 50	11.3

PROB. XXX.

The Altitude of Aldebaran (or any other Star) being given in a known Latitude; To finde the Star's Azimuth.

Practice.] **T**HE Quadrant of Altitude being fixed in the *Zenith*, move it and the Globe, till the degrees of Altitude given do meet with the centre of the Star; then shall the end

end of the Quadrant of Altitude shew you upon the Horizon the *Azimuth* in which the Star then is. And thus, if you bring the Quadrant of Altitude on the East-side of the Globe, moving it and the Globe both, till the centre of *Aldebaran* do meet just with 42 deg. of the Quadrant, you shall then finde the Quadrant of Altitude to rest at 33 deg. of the Horizon, counted from the East; or at 57 deg. if you count them from the South: and that is the *Azimuth* of *Aldebaran* when he hath 42 deg. of Altitude; and that is neer the S. E. by E. point of the Compass.

The Latitude of the Place (51 deg. 30 min.) and the Declination of a Star (suppose the *Bulls eye*, *Aldebaran*) given : To finde

PROB. XXXI.

Its Right Ascension.

Practice.] THE Globe Rectified to the Latitude, &c. bring *Aldebaran* to the Meridian : then count how many degrees of the Equinoxial are contained between the Meridian and the beginning of *Aries* ; which will be 64 deg. 17 min. and that is the *Right Ascension* of that Star ; which in time (by allowing 15 deg. for an hour , and 1 deg. for 4 min. of time) is 4 hours 16 min. its *Right Ascension* in time.

And in the same manner may you finde

		d. m.		h. m.	
The Right Ascension of	<i>Arcturus</i>	} to be }	210.13	} in time }	14. 1
	<i>Syrus</i>		97.42		6.30
	<i>Algol</i>		39.39		2.38

PROB.

PROB. XXXII.

Its Ascensional Difference.

Practice. Bring the Star to the Meridian, and the Hour-Index to 12. Then bring the Star either to the East or West-side of the Horizon, and there you shall finde 1 hour and 27 min. contained between the Index and 6 a clock : and such is the *Ascensional Difference of Aldebaran.*

In like manner, you may finde

		d. m.		h. m.		
The Ascensional Difference of	<i>Arcturus</i>	} to be	{	28 40	} or in time	1.55
	<i>Syrus</i>			21.28		1.26
	<i>Algol</i>			—		—

Algol his Declination being more than the Complement of the Latitude, never rises nor sets, but is always above the Horizon.

PROB. XXXIII.

Its Amplitude.

Practice. Bring *Aldebaran* to the Horizon on either side of the Globe, and you shall finde it to touch the Horizon at 25 deg. 56 min. from the East or West Northward; which is the *Amplitude* of the *Bulls eye's* rising or setting. And according to the points of the Compass it riseth E.N.E. 2 deg. 26 min. Northerly; and sets W.N.W. 2 deg. 26 min. Northerly.

And thus may you finde

			d. m.
That	<i>Arcturus</i>	Riseth from	Northward 35. 6
	<i>Syrins</i>	the East or	Southward 26. 41
	<i>Algol</i>	West	Never rises or sets

PROB. XXXIV.

The Semidiurnal Arch, and the time that Aldebaran (or any other Star) continues above the Horizon.

Practice. **B**Ring *Aldebaran* to the Meridian, and set the Hour-circle to 12. Then turn the Globe Westward, till *Aldebaran* touch the Horizon: then shall the Hour-Index point at 7 ho. 27 min. And so long time is *Aldebaran* above the Horizon, before he comes to the Meridian; and continues so many hours and minutes above the Horizon, after he hath past the Meridian, and sets in the West. And those 7 ho. and 27 min. is the *Semidiurnal Arch* of that Star; which doubled, is 14 ho. 54 min. And so long doth that Star continue above the Horizon after the time of his rising.

And in this manner you may finde

		d. m.		h. m.
The Semi-diurnal Arch of	<i>Arcturus</i>	7.55	And his continuance above the Horizon	15.50
	<i>Syrins</i>	4.34		9. 8
	<i>Algol</i>	12.00		24.00

PROB.

PROB. XXXV.

At what hour (any time of the year) Aldebaran comes to the Meridian.

Practice. **L** Et the time be the first of *January*, at which time the *Sun* is in 22 deg. of *Capricorn*. Bring 22 deg. of *Capricorn* to the Meridian, and set the Hour-Index to 12. Then turn the Globe about till *Aldebaran* be under the Meridian, and then you shall finde the Index to point at 42 min. after 8 of the clock, at which time *Aldebaran* will be upon the Meridian that night.

In like manner you may finde, that

				h	m.
Upon	<i>October 28</i>	<i>Arcturus</i>	will be up-	11	10
	<i>January 21</i>	<i>Syrus</i>	on the Me-	9	33
	<i>January 1</i>	<i>Algol</i>	ridian at	7	12

PROB. XXXVI.

At what hour (at any time of the year) Aldebaran (or any other Star) riseth or setteth.

Practice. **L** Et the time be *January 1*. By the last before-going, you found that *Aldebaran* came to the Meridian at 8 ho. 42 min. And by the last but one, you found his Semidiurnal Arch to be 7 ho. 27 min. This being taken from 8 ho. 42 min. the time of his being South, leaveth

leaveth 1 hour 15 minutes, the time of its Rising: so that upon the first of *January Aldebaran* did rise at 15 min. after 1 in the afternoon. Again, if you add his Semidiurnal Arch 7 hours 27 min. to the time of its being South 8 hours 42 min. the sum will be 16 hours 9 min. from which take 12 hours, and the remainder will be 4 hours 9 min. So that *Aldebaran* will set at 9 min. after 4 of the Clock the next morning. And in like manner you may finde, that

Upon { October 28 Arcturus } Rises at { h. m. 3. 8 } Sets at { h. m. 7. 12 }

{ January 21 Syrius } Rises at { h. m. 5. 3 } Sets at { h. m. 2. 3 }

{ January 1 Algol } Rises at { h. m. — } Sets at { h. m. — }

***Algol* never Rises nor Sets.**

Р О В. XXXVII.

At what Horary distance from the Meridian Aldebaran will be due East or West : And what Altitude he shall then have.

Practice. **B** Ring *Aldebaran* to the Meridian, and the Hour-Index to 12. and the Quadrant of *Altitude* to the West-point of the *Horizon*: then turn the Globe Eastward, till the Centre of the *Star* be just under the edge of the Quadrant; then shall the Index point at 5 hours and 40 min. So that when *Aldebaran* is due East or West, he will be 5 hours 40 min. of time short of, or gone beyond the Meridian.

And

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And when the Centre of *Aldebaran* is just under the Edge of the Quadrant of *Altitude*, you shall finde it to touch 20 deg. 21 min. And such is the *Altitude* of *Aldebaran* when he is upon the East or West *Azimuth*. In like manner may you finde, that

		h. m.		d. m.
<i>Arcturus</i> <i>Syrinx</i> <i>Algol</i>	{ will be upon the East or West <i>Azimuth</i> , when he is distant from the Meridian	4.49	{ and his <i>Altitud</i> will be	27.13
		5.04		20.56
		3.15		54.37

PROB. XXXVIII.

What *Altitude* and *Azimuth* *Aldebaran* (or any other *Star*) shall have when six hours distant from the Meridian.

Practice. B Ring *Aldebaran* to the Meridian, and the Index to 12; Then turn the Globe about till the Index point at 6: then lay the Quadrant of *Altitude* over the Centre of the Star, and you shall finde it to lie under 12 deg. 18 min. of the Quadrant: and such is the *Altitude* of *Aldebaran*. At the same time look what degrees of the *Horizon* are cut by the Quadrant of *Altitude*, and you shall finde 8 degrees between it and the East or West Points Northwards. And such is the *Azimuth* of *Aldebaran*. And according to this Rule you shall finde, that when

		<i>Altit.</i> d. m.	<i>Azim.</i> d. m.	
<i>Arcturus</i> <i>Algol</i>	{ is 6 hours distant from the Merid. his	16.15	76.36	{ from the North.
		12.38	79.43	

Syrinx

Syrius is never 6 hours distant from the Meridian, nor any other Star that hath South-declination.

PROB. XXXIX.

To finde what Altitude and Azimuth any Star hath when he is at any horary distance from the Meridian.

Practice. **T**His is no other than the last. For having brought the Star to the Meridian, and the Index to 12, move the Globe till it come to the designed hour. Then the *Quadrant of Altitude* being laid over the Star, shall at the same time shew you both the *Altitude* and *Azimuth* thereof as before. This needeth no Example.

PROB. XL.

Having the Azimuth of a Star, to finde at what horary distance that Star is from the Meridian, and what Altitude that Star then hath.

Practice. **B**Ring the Star to the Meridian, the Index to 12, and the *Quadrant of Altitude* to the *Given Azimuth*; then turn the Globe about till the Centre of the Star lie just under the *Quadrant of Altitude*; the Index at that

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that time shall give the *horary distance*, and *Quadrant* the *Altitude* of the *Star*.

Example: *Aldebaran* being seen upon 80 degrees of *Azimuth* from the North-Westward, that is, near upon the W. by N. Point of the *Compass*; the *Star* brought to the *Meridian*, and the *Quadrant of Altitude* to 80 degrees, and the *Hour-Index* to 12. If you bring the *Star* to the *Quadrant of Altitude*, you shall finde the *Index* to point at 6 hours, which is the *Stars horary distance* from the *Meridian*. And the *Quadrant of Altitude* will shew 12 deg. 18 min. the *Altitude* of *Aldebaran* at that time.

PROB.

PROB. XLI.

Concerning the Poetical Rising
and Setting of the fixed Stars
viz.

The { Cosmical
Acronical } Rising and Setting.
Heliacal

And how to finde either of them by the
Globes.

1. Of the Cosmical Rising and Setting.

Definition. A Star is said to Rise *Cosmically*, when it Riseth with the Sun, or with that degree of the Ecliptick in which the Sun then is. And the *Cosmical Setting* is, when a Star setteth in the Morning, or goeth down under the Western Horizon in the Morning at such time as the Sun is Rising in the East.

Practice. Upon the 27 of May, the Sun then being in 17 degrees of Gemini, I would know what Stars do then Rise and Set *Cosmically*. Rectifie the Globe to your Latitude, and bring the 11 degree of *Aquarius* to the East-part of the Horizon: then look what Stars are about the edge of the Eastern Semi-circle of the Horizon, for all those Stars do that day Rise *Cosmically*. And those Stars which touch or are neer the Rim of

the West Semi-circle of the *Horizon* do Set at that time *Cosmically*. So shall you finde

May 27	{	Aldbaran or the Bulls eye, with divers other smaller Stars,	}	Rising, and	{	The right leg of <i>Serpentari- us</i> and several other smaller Stars	}	Setting <i>Cosmi- cally</i> .
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2. Of the Acronical Rising and Setting of the Stars.

Defini- tion.] A Star is said to Rise *Acronically* when it Riseth in the East-*Horizon*, at such time as the *Sun* goes down or Sets in the West-*Horizon*; and the *Acronical* Setting is when a Star goeth down under the *Horizon* with the *Sun*.

Practice.] Upon the 18 of *October*, in the *La- titude* of 51 deg. 30 min. the *Sun* then being in 5 deg. of *Scorpio*, I would know what Stars do on that day Rise and Set *Acronically*. Rectifie the Globe to the *Latitude*, bringing the place of the *Sun* 5 deg. of *Scorpio* to the West-part of the *Horizon*, then shall all those Stars which you see on the Verge of the East-side of the *Horizon*, be Ri- sing *Acronically*. And all those that are about the Verge of the Western part of the *Horizon* are then Setting *Acronically*. And so upon the fore- mentioned day, you shall finde

A Star in the <i>Whales Tail</i> , and several other smal- ler Stars	{	Rising, and	{	The Tail of the <i>Lyon</i> , the South Ballance, and several other smaller Stars	}	Setting <i>Acronically</i> .
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3. Of the Heliacal Rising and Setting of the Stars.

Definition.] A Star is said to Rise *Heliacally*, when having been some time combust, (or hid under the *Sun-beams*) begins now to appear, it being at greater distance from the *Sun*. And a Star is said to Set *Heliacally*, which hath some small time before been seen, but now, by the neer approach of the *Sun*, becomes combust and hidden under his *Beams*. Now to know when a Star begins to become combust, & when to be freed from his combustment of the *Sun-beams*, no certain Rule can be given: for the *Magnitude of the Star*, the *difference of the Climate*, the *cloudiness or serenity of the Air* may much alter. But the Opinion of the Ancient Astronomers was, that

			deg.	
A Star	$\left. \begin{array}{c} 1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \end{array} \right\}$	Magnitude may be seen when the Sun is but	$\left. \begin{array}{c} 12 \\ 13 \\ 14 \\ 15 \\ 16 \\ 17 \end{array} \right\}$	below the Horizon.
of the				

And those which are only Nebulous, cannot be seen till the *Sun* be 18 deg. under the *Horizon*.

Practice.] Rectifie the Globe to the *Latitude*, and the *Quadrant of Altitude* in the *Zenith*; then bring the given Star (suppose *Regulus*, or the *Lions*

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Lions Heart) to the East-side of the Horizon
and the *Quadrant of Altitude* to the West-side
then *Regulus* being a Star of the First Magnitude
(by the former Rule of the Ancients) may be
seen when the *Sun* is but 12 deg. below the Ho-
rizon: wherefore see what degree of the *Ecliptick*
doth cut the *Quadrant of Altitude* in 12 degrees,
which you shall finde to be 9 deg. of *Pisces*, the
opposite degree to which is 9 deg. of *Virgo*; to
which Signe and degree when the *Sun* cometh,
(which will be about the 23 of *August*.) then
will *Regulus*, the *Lions heart*, Rise *Heliacally*:
Then for the *Heliacal Setting*, bring the *Star* to
the West-side of the Horizon, and turn the *Qua-*
drant of Altitude to the East-side, and see what
degree of the *Ecliptick* is elevated upon the *Qua-*
drant, as the Magnitude of the *Star* you deal
with doth require. For when the *Sun* comes to
the opposite degree of the *Ecliptick*, that *Star*
shall Set *Heliacally*. So

The <i>Pleiades</i>	} shall Rise Heliacal- ly upon	{ <i>June 4</i> <i>June 26</i> <i>Sept. 26</i>	and Set	{ <i>April 29</i> <i>April 22</i> <i>Novem. 19</i>
<i>Aldebaran</i>				
<i>Antares</i>				

Concerning the *Cosmical* and *Acronical* Rising
of the Stars, see the following Table,

G

A

A T A B L E,

Shewing the time of the Year
when 50 eminent Stars do Rise
both *Cosmically* and *Acronically*.

Calculated for the Year 1670, and may
serve for many Years past, and to come, with-
out any considerable Errour.

Names of the S T A R S.	Their Cosmical Rising.	Their Acronical Rising.
<i>March</i> <i>β</i> <i>Pegasi</i>	Jan. 1	March 1
Right Shoulder of <i>Aquarius</i>	6	Feb. 14
Extream Star in the Wing of <i>Pegasus</i>	28	19
Following Tail of the Goat	Feb. 5	Jan. 24
Bright Star in the <i>Rams-head</i>	March 2	April 20
The following Horn of the Ram	5	19
The former Horn of the Ram	April 10	19
North-Tail of the <i>Whale</i>	12	March 19
The brightest of the <i>Pleiades</i>	22	May 10
The Star in the Knot in the Net of <i>♋</i>	May 1	April 29
North-Horn of the <i>Bull</i>	15	June 9
North-Eye of the <i>Bull</i>	20	May 12
Belly of the <i>Whale</i>	23	March 16
Bulls-Eye, <i>Aldebaran</i>	27	May 21
South-Horn of the <i>Bull</i>	June 6	June 17
Lower Head of <i>Gemini</i> , <i>Hercules</i>	21	July 20
Bright Foot of <i>Gemini</i>	25	June 9
Middle Star in <i>Orions Girdle</i>	July 2	May 4
North- <i>Asellus</i>	12	July 29
Presepce	14	19
South- <i>Asellus</i>	17	17

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Names of the S T A & S.	Their Casual Rising.	Their Acrosta Rising.
Lesser Dog, <i>Procyon</i>	July 18	June 6
Great Dog, <i>Palsicium</i>	30	May 3
Lions Heart	August 8	August 9
Lions Back	10	Octob. 19
Hydra's Heart	20	June 16
Lions Tail	22	Octob. 16
Hares Thigh	Sept. 9	April 14
Prodiatrix	13	Novem. 8
Arcturus	15	Decem. 13
Virgins Girdle	19	Octob. 18
Bright Star of the Crown	28	Jan. 7
Virgins Spike	Octob. 3	Sept. 24
Right Shoulder of Hercules	6	Jan. 9
Left Shoulder of Hercules	16	21
Head of Hercules	22	28
North Balance	27	Novem. 17
South Balance	23	Octob. 24
Swans Bill	21	Feb. 16
Right Shoulder of Ophiurus	Novem. 5	Jan. 4
Left Knee of Ophiurus	6	Decem. 6
Lower Wing of the Swan	4	March 1
Peacocks Tail	11	Jan. 27
Right Knee of Ophiurus	16	Decem. 6
Scorpius Heart	22	Novem. 14
The Eagle	23	Decem. 21
Pegasus's Head	Decem. 11	March 24
Andromeda's Girdle	22	April 29
Andromeda's Head	25	6
Upper Horn of the Crab	25	Jan. 14

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TRI-

TRIGONOMETRICAL PROBLEMS.

INTRODUCTION.

Spherical Triangles are best represented by the Circles upon, and those appendant to, the Globe; with whose nature, affections, and uses, the Practitioner ought thoroughly to be acquainted, before he enter upon the Solution of such Triangles by the Canons or Tables, either of Natural or Artificial Sines and Tangents, or by other Instruments, as Projections, Planispheres, or the like; the Globe being the Original from whence all these do proceed. For by the true understanding of the Uses of the Globe, it will not be difficult to Project the Sphere in Plano upon any Circle, as I have in some measure taught how to do upon the Plain of the Meridian, in my Geometrical Exercises, and shall here farther illustrate by the Circles upon the Globe it self; upon which the Sides and Angles of all Spherical Triangles, are most Naturally represented, and most Expeditiously measured. But before I come to the Practice hereof, give me leave to premise such general and necessary Definitions and Affections, as do in any case belong to Spherical Triangles. And (1) Of such Lines or (rather) Arches of Circles, of which Spherical Triangles are framed and measured. (2) Of the Kinds, Parts and

and Affections of such Triangles so constituted: how the things given or required in them are represented upon the Globe; with the Variety of Questions, that the solution of every Spherical Triangle will afford. With (3) The solution of several Problems for Practice.

Of the Definitions and Affections of Triangles.

1. **A**LL Triangles do consist of six parts, viz. of three *Sides*, and as many *Angles*.
2. The three sides of a Spherical Triangle do consist of three *Arches* of *Great Circles* of the *Sphere* or *Globe*, each *A* *b* being less than a *Semi-circle*, or 180 deg.
3. A *Great Circle* of the *Globe*, is that which divideth the *Globe* into two equal parts; such are the *Meridians*, *Equinoctial*, *Ecliptick*, the *Colures*, &c.
4. The three *Angles* of a Spherical Triangle, are measured by three *Arches* of *great Circles* described upon the three *angular Points* of the Triangle; and are either *Right*, *Acute*, or *Obtuse*.
5. A *Right-angled Spherical Triangle*, is that which hath either *One*, or more *Right Angles*, which contains 90 deg. An *Acute-angled Spherical Triangle* is that whose three *Angles* be all of them *acute*; that is, each of them less than 90 degrees.
6. An *Obtuse Angle* is that *Spherical Triangle* whose *Angles* are all *obtuse*, each exceeding 90 deg. or else *mixt*, some *Obtuse* and some *Acute*.

7. The Complement of a Side or Angle to a Quadrant or 90 deg. is so much as that Side or Angle wants of 90 degrees.

8. The Complement of a Side or Angle to a Semi-circle or 180 deg. is so much as that Side or Angle wants of 180 degrees.

9. All Spherical Triangles which have not One or more Right Angles, are called Oblique angled Spherical Triangles.

Hence it followeth, That

1. If two Great Circles of the Sphere shall pass by each others Poles, those two Circles shall intersect each other at Right Angles. But

2. If two Great Circles of the Sphere do intersect each other, and do not pass through each others Pole, those two Circles shall intersect each at other Oblique Angles. Thus

The General Meridian and the Horizon,

The Colures and the Equinoctial

The Vertical or Vertical Circles & the Horizon,

The Circle of Latitude and the Ecliptick,

} do intersect
each other at
Right Angles.

But

The Colures and the Horizon

The Vertical Circles and Equinoctial

The Circle of Longitude, Horizon,

and the

Equinoctial

} do intersect each
other at Oblique
Angles.

And the Angles made by these oblique intersections, are on the one side of the intersection Acute, and on the other side Obtuse. So

3. Two Arches of Great Circles intersecting each other, shall make on both sides the intersection,

on,

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on either two *Right Angles* or two *Oblique Angles*, the one *Acute*, the other *Obtuse*; of which, both of them being taken together, shall be equal to two *Right Angles*, or 180 degrees. Thus, in the Latitude of 51 deg. 30 min.

	d. m.	
The Meridian	intersecting with	90.00
The Ecliptick	the Horizon doth	62.00
The Equinoctial	make an Angle of	38.30
	d. m.	
	90.00	on the one
	118.00	side of the
	141.00	intersection,
		d. m.
	90.00	on the other
	118.00	side of the
	141.00	intersection,

And both the *Angles* on either side together, are equal to two *Right Angles*, or 180 degrees. But here note, That these *Angles* do Vary in every Latitude, and are not always the same.

4. If a *Spherical Triangle* have three *Right Angles*, the three sides of that *Triangle* shall be all *Quadrants*, each containing 90 deg. So (in a *Parallel Sphere*)

The *Brass Meridian* cutting the *Horizon* in the North and South-points of the *Horizon* at *Right Angles*, and the *Equinoctial Colure* in the East and West-points of the *Horizon* at *Right Angles*, and the *Meridian* and *Colure* intersecting each other in the *Pole* of the *World*, at *Right Angles* also: do constitute a *Spherical Triangle* with three *Right Angles*; and the three sides of this *Triangle*, (for this Reason) shall be all of them *Quadrants*: for upon the *Meridian*, between the *Equinoctial* (which is also the *Horizon* in a *Parallel Sphere*) and the *Pole*, is contained 90 degrees: also upon the *Colure* between the *Equinoctial* and the *Pole*

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is also 90 degrees; and between the *East* and *North* or *South*-points of the *Horizon* is also contained 90 degrees: So that the three *Angles* being *Right Angles*, the three *Sides* are also three *Quadrants*.

5. If a *Spherical Triangle* hath two *Right Angles*, the *Sides* opposite to those *Angles* shall be *Quadrants*; and the third side shall be the measure of the other *Angle*. Such *Triangles* as these do seldom come in *Practice*, for few or no *Questions* can arise out of them; but of *Right angled Spherical Triangles*, those that have *One Right*, and *Two Acute Angles*, most *Questions* are resolvable by.

6. An *Acute angled Spherical Triangle*, hath all its sides less than *Quadrants*, or 90 degrees.

7. An *Obtuse angled Triangle*, having all its *Angles* *Obtuse*, hath all its *Sides* more than *Quadrants*: If mixt, the *Side* or *Sides* opposite to the *Obtuse Angle* or *Angles* shall be *Greater*, and the *Side* or *Sides* opposite to the *Acute Angle* or *Angles* shall be *Less* than *Quadrants*.

8. The *Sides* of *Spherical Triangles*, are of the same *affection* or *kinde* with their *opposite Angles*.

9. In *Right-angled Spherical Triangles*, the *Side* which is opposite to the *Right Angle*, I call the *Hypotenuse*; and the other two *Sides* which contain the *Right Angle*, I call the *Sides* or *Legs*.

10. In *Oblique angled Spherical Triangles*, I call the *Sides* *Sides*, and the *Angles* *Angles*, without any other distinction.

11. In the *Solution* of *Right-angled Spherical Triangles*, there are usually 16 *Cases*, which will all be reduced to *Five*; for that by the *Globe* three

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three things are at once found. And in Oblique Angled Spherical Triangles, there are usual 12 Cases, which by the Globe will be reduced to 6; the Globe answering two at one Position.

Thus much of the Definitions and Affections of Spherical Triangles.

Of the Solution of Spherical Triangles upon the Globe.

IN the following Scheme or Figure of the Sphere or Globe, it being in an Oblique Position, viz. Elevated to the Latitude of London, 51 deg. 30 min. you have upon the Superficies thereof divers Spherical Lines and Circles, by the intersections whereof, are constituted divers Spherical Triangles; some whereof are Right-angled, and others Oblique-angled: Of which I shall make use only of Two; one for the Five Cases of Right-angled Triangles, the other for the Six Cases of Oblique-angled Triangles.

The Triangle which I shall make use of for the Five Cases of Right-angled Triangles, shall be the Triangle P. O. \odot , Right-angled at O.

In

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In which Right angled Spherical Triangle P. O. ☉
P. ☉. being an Arch of the Brass Meridian,
we suppose to be the Latitude of Lon-
don, 51 deg. 30 min.

☉. O. being an Arch of the Horizon, we sup-
pose to be the Amplitude of the Sun's
Rising or Setting, from the North-part
of the Meridian 56 deg. 40 min.

P. ☉. being the Arch of another Meridian,
or Hour-Circle, (which the Equinoctial
Colure will best supply or represent) we
suppose to be the Sun's distance from the
Pole, or the Complement of his Decli-
nation, 70 deg. 00 min.

☉. P. O. is the hour from midnight, whose
measure is to be reckoned upon the E-
quinoctial, between the Equinoctial Colure
and the Brass Meridian, and will be 62
deg. 45 min. or in time 4 hours 11 min.

P. ☉. O. is the Angle of the Sun's Position at the
time of the Question, whose measure is
the Arch of a Great Circle, comprehen-
ded between the Complement of the
side ☉. O. on the Horizon, and the
Complement of the Side ☉. P. on the
Equinoctial Colure, both those Sides be-
ing continued to Quadrants, on the
contrary Side of the Brass Meridian,
and will contain 56 deg. 39 min.

P. O. ☉. is the Right Angle, whose measure is
the deg. of the Quadrant of Altitude
contained between the East or West-
points of the Horizon and the Zenith,
which is 90 deg.

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The several parts of the Triangle being thus declared, let us now proceed to the several Cases which arise out of this, and every Right-angled Spherical Triangle.

Of Right-angled Spherical Triangles.

CASE I.

The two Sides (or Legs) $P. Q.$ 51 deg. 30 min. and $Q. O.$ 56 deg. 40 min. being given to finde the Hypotenuse $P. O.$ and the Angles $\odot. P. Q.$ and $P. \odot. O.$

Seeing that the Side $P. Q.$ is an Arch of the Brass Meridian, and contains 51 deg. 30 min. count thereupon from the Pole, 51 deg. 30 min. and bring those degrees to the Horizon. Then the Side $Q. O.$ being an Arch of the Horizon, and contains 56 deg. 40 min. count upon the Horizon, from the Meridian, 56 deg. 40 min. and turn the Globe about till the Equinoctial Colure do touch those degrees of the Horizon, so shall you have the true Triangle perfectly described upon the Globe in self; For from the Pole to the Horizon, upon the Meridian, is equal to $P. Q.$ From the Horizon to the Pole, upon the Colure is equal to $P. O.$ And from the Colure to the Meridian, upon the Horizon is equal to $Q. O.$ Now (1.) $P. Q.$ being 51 deg. 30 min. and $Q. O.$ 56 deg. 40 min. the degrees of the Colure counted from the Pole to the Horizon, will be found 70 degrees; for

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for the *Hypotenuse* P. \odot . which was required.
 (2.) For the Angle \odot . P. O. count the degrees
 of the *Equinoctial* which are contained between
 the *Colure* and the *Brass Meridian*, and you shall
 finde them to be 62 deg. 45 min. or 4 hours 11
 min. for the quantity of the Angle \odot . P. O. (3.)
 For the Angle P. \odot . O. count the Complement
 of \odot . P. 20 degrees upon the *Equinoctial Colure*,
 on the other Side of the *Meridian* (so shall that
 Point be distant from the Point \odot . 90 deg.) Al-
 so, count the Complement of the Side \odot . O. viz.
 33 deg. 20 m. upon the *Horizon*, on the other Side
 of the *Meridian*, (which Point will be 90 deg.
 distant from the Point \odot . upon the *Horizon*)
 So shall the distance between these two Points,
 (measured by the Quadrant of *Altitude*, or by
Compasses) contain, 56 deg. 39 min. for the An-
 gle P. \odot . O.

Or, This Angle P. \odot . O. may be otherwise
 found in the same manner as you found the An-
 gle \odot . P. O. (but then you must alter the Posi-
 tion of the *Globe*) For, if you Elevate the *Globe*
 to 56 deg. 40 min. the Side \odot . O. and bring the
Equinoctial Colure to 31 deg. 30 min. of the *Ho-
 rizon*, which is the Side P. O. (for so have you
 turned the Triangle upside-down) then will the
 degrees of the *Equinoctial* intercepted between
 the *Equinoctial Colure* and the *Brass Meridian*, be
 56 deg. 39 min. as before, and equal to the Angle
 P. \odot . O.

Or this is the usual Way taught by others, where
 by the *Globe* must be often Rectified upon eve-
 ry small occasion. But I embrace the first way.

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as being both *Exact* and *Natural*; but having declared both ways, I leave every one at liberty to use that which he best liketh.

So by this one *Data* you have resolved three *Problems* of the Sphere; for you have found

1. The Side $P. \odot$. the Complement of the Suns Declination 70 degrees.
2. The Angle $\odot. P. O$. the hour from Midnight 4 hours 11 minutes.
3. The Angle $P. \odot. O$. the Angle of the Suns position 56 degrees 39 minutes.

CASE. II.

The Hypotenuse $P. \odot$. 70 degrees, and the Side (or Leg) $P. O$. 51 deg. 30 min. being given; to finde the other Leg, $O. \odot$. and the Angles $\odot. P. O$. and $O. \odot. P$.

THis Case differeth little from the former: for $P. O$. being an Arch of the Meridian, and containing 51 deg. 30 min. the Meridian being set hereto in the Horizon, turn the Globe about till 70 deg. of the Equinoctial Colure do touch the Horizon. So shall you finde the degrees of the Horizon intercepted between the Colure and the Meridian to be 56 deg. 40 min. for the Side $O. \odot$. The Angles at P . and \odot . are to be found in all respects by their measures, as in the former Case.

And by this one *Data*, you have resolved three other

gave other Problems of the Sphere, for by it you
-120 have found

1. \odot . \odot . The Sun's Amplitude from the
North, 56 deg. 40 min.

2. \odot . P . \odot . The hour from midnight 62
d g. 45 min. or 4 h. 11 min.

3. P . \odot . \odot . The Angle of the Sun's posi-
tion, 56 deg. 39 min.

And if instead of Leg P . \odot . there had
been given the Leg \odot . \odot . you might
have then found [by bringing 70
degrees of the Equinoctial Colure, to
meet with 56 deg. 40 min. of the Ho-
rizon]

4. P . \odot . The Latitude 51 deg. 30 min.

5. \odot . P . \odot . The hour from midnight.

6. P . \odot . \odot . The Angle of the Sun's posi-
tion 56 deg. 39 min.

CASE III.

The Hypotenuse P . \odot . 70 deg. and the An-
gle P . 62 deg. 45 min. at being given, to
find the two Legs P . \odot . and \odot . \odot . and
the Angle P . \odot . \odot .

Count the Angle P . 62 deg. 45 min. upon the
Equinoctial from the Colure, and bring that
point to the Brass Meridian, and there keep the
Globe fast in the Meridian; then move the Brass
Meridian upwards or downwards in the Ho-
rizon, till 70 deg. of the Equinoctial Colure do
justly

justly touch the *Horizon*, then shall the *Brass Meridian* rest in the *Horizon*, at 51 deg. 30 min. for the Side P. O. and the degrees of the *Horizon* intercepted between the *Equinoctial Colure* and the *Meridian* will be 56 deg. 40 min. for the Side O. O. and the distance between 33 deg. 20 min. of the *Horizon*, and 20 degrees of the *Equinoctial Colure* shall be 56 deg. 30 min. for the Angle P. O. O.

So that by this single *Data* there are also three other *Problems* resolved, viz. there is found

1. The P. O. the *Latitude* 51 deg. 30 min.
2. The Side O. O. the *Amplitude* from the North 56 deg. 40 min.
3. The Angle P. O. O. the Angle of the *Sun's* position.

And if instead of the Angle at P. the Angle at O. had been given, you might then have found [by counting 20 deg. upon the *Equinoctial Colure*, and to that point apply 56 deg. 39 min. of the *Quadrant of Altitude*, (or a pair of *Compasses* opened to that distance.) then turn the *Meridian* in the *Horizon*, and the *Globe* about his *Axis*, till 70 deg. of the *Colure* and 00 deg. of the *Quadrant of Altitude* do touch the *Horizon* on either side of the *Meridian*: for then will the *Meridian* rest in the *Horizon*, at 51 deg. 30 min.]

4. The Side O. O. the *Amplitude* from the North 56 deg. 40 min.
5. The Side P. O. the *Latitude* 51 deg. 30 min.
6. The Angle O. P. O. the hour from mid-night 62 deg. 45 min.

CASE

CASE IV.

One Leg \odot . O. 56 deg. 40 min. and one Angle P. \odot . O. 56 deg. 39 min. being given; to finde the Side P. O. the Hypotenuse P. \odot . and the Angle \odot . P. O.

Count upon the *Horizon* from the *Brass Meridian* 56 deg. 40 min. the given Side (or Leg) \odot . O. also from the *Brass Meridian*, on the contrary side thereof, count 33 deg. 20 min. the Complement of \odot . O. to which degrees apply 00 deg. of the Quadrant of *Altitude*. Then move the *Brass Meridian* up and down in the *Horizon*, till the *Equinoctial Colure* cuts 56 deg. 40 min. and 56 deg. 39 min. of the Quadrant of *Altitude* do intersect the *Colure*. So will the *Brass Meridian* rest in the *Horizon* at 51 deg. 30 min. For the Side P. O. the *Horizon* will cut the *Equinoctial Colure* in 70 deg. For the Hypotenuse P. \odot . and the degrees of the *Equinoctial* intercepted between the *Equinoctial Colure* and the *Brass Meridian*, will be 62 deg. 45 min. for the quantity of the Angle \odot . P. O. which was required.

And by this *Data*, there are three Problems resolved: for there is found

1. The Side P. O. the Latitude 51 d. 30 m.
2. The Angle \odot . P. O. the hour from Midnight 62 deg. 45 min.
3. The Side P. \odot . the Sun's distance from the Pole 79 deg.

But if the *Given Leg* had been $\odot. O.$ and the *Given Angle* $\odot. P. O.$ [by counting the *Angle P.* upon the *Equinoctial*, and bringing that point to the *Meridian*, and moving the *Meridian* up and down in the *Horizon*, till the *Equinoctial Colure* did touch $56 \text{ deg. } 40 \text{ min.}$ of the *Horizon*] you should then have found

4. The *Hypotenuse* $P. \odot.$ the *Sun's* distance from the *Pole* 70 deg.

5. The *Side* $P. O.$ the *Latitude* $51 \text{ d. } 30 \text{ m.}$

6. The *Angle* $P. \odot. O.$ the *Angle* of the *Sun's* position $56 \text{ deg. } 39 \text{ min.}$

Also, if the *Hypotenuse* $P. O.$ and the *Angle* $\odot. P. O.$ had been given [by counting the *Angle* $\odot. P. O.$ upon the *Equinoctial*, and bringing it to the *Meridian*, and moving the *Meridian* in the *Horizon*,

till 70 deg. of the *Equinoctial Colure* did touch the *Horizon*] you might then find
7. The *Side* $O. Q.$ the *Sun's* *Amplitude* from the *North* $56 \text{ deg. } 40 \text{ min.}$

8. The *Side* $\odot. P.$ the *Sun's* distance from the *Pole* 70 deg.

9. The *Angle* $P. \odot. O.$ the *Angle* of the *Sun's* position $56 \text{ deg. } 39 \text{ min.}$

And again, if the *given Side* (or *Leg*) had been $P. O.$ and the *Angle* $O. \odot. P.$ [by setting the *Brass Meridian* to $51 \text{ d. } 30 \text{ m.}$ in the *Horizon*, and turning the *Body* of the *Globe* about till the *Equinoctial Colure* and the *Horizon* do make an *Angle* of $56 \text{ deg. } 39 \text{ min.}$] you might then find

10. The *Hypotenuse* $P. \odot.$ the *Sun's* distance from the *Pole* 70 deg.

11. The Side $\odot O$. the Sun's Amplitude from the North $56^{\circ} 40'$ min.

12. The Angle $\odot P O$. the hour from midnight $62^{\circ} 45'$ min.

CASE V.

The two Acute Angles $\odot P O$. $62^{\circ} 45'$ min. and $P \odot O$. $56^{\circ} 39'$ min. being given, to finde the Side $R O$. $P \odot$. and $\odot O$.

Count the quantity of the Angle $\odot P O$. $62^{\circ} 45'$ min. upon the Equinoctial, from the Equinoctial Colure, bringing those degrees to the Meridian, and there fix the Globe; then move the Meridian upward or downward in the Horizon, till the intersection of the Equinoctial with the Horizon do make an Angle of $56^{\circ} 39'$ min. So shall the Side $R O$ be found to be $51^{\circ} 30'$ min. the Leg $\odot P$. $56^{\circ} 40'$ min. and the Hypotenuse $P \odot$. 70° deg.

And from this Data, three Problems are resolved; for you have found

1. The Side $P \odot O$. the Latitude $51^{\circ} 30'$ min.
2. The Side $\odot P$. the Amplitude from the North $56^{\circ} 40'$ min.
3. The Hypotenuse $P \odot$. the Sun's distance from the Pole 70° deg.

This last Case may best be resolved by changing of the Angles into Sides, as shall be hereafter taught. These

These are the Five Cases of Right-angled Spherical Triangles: And here you see that in this one Right-angled Spherical Triangle, by the several Parts given in these Five Cases, there are 30 Spherical Problems resolved: Namely, 3 by the First Case, 6 by the Second Case, 6 by the Third Case, 12 by the Fourth Case, and 3 by the Fifth Case. And so many are resolvable in every Right-angled Spherical Triangle.

Of Oblique-angled Spherical Triangles.

The Triangle which I shall make use of for the resolving of the Six Cases of Oblique-angled Spherical Triangles, shall be the Oblique Triangle Z. P. E. Obtuse angled at Z.

In which Triangle

Z. P. being an Arch of the Brass Meridian, we will suppose to be the Complement of the Latitude of London, containing 38 deg. 20 min.

P. E. being an Arch of a Meridian (or Hour-Circle,) we will suppose to be the Sun's distance from the Pole, or the Complement of the Sun's Declination Northward 70 deg.

Z. E. being an Arch of an Azimuth (or Vertical Circle) let be the Complement of the Sun's, or a Star's Altitude, and to contain 47 deg. 12 min.

Z. P. E. is the *hour from Noon*, whose measure is to be reckoned upon the *Equinoctial*, between the *Equinoctial Colure* and the *Brass Meridian*, and will be found to be 45 deg. or 3 ho. in time.

E. Z. P. is the *Sun's Azimuth* from the North part of the *Meridian*, and is to be measured upon the *Horizon* between the North part of the *Brass Meridian*, and the *Quadrant of Altitude*, and will be found to be 15 deg. 25 min.

Z. E. P. is the *Angle of the Sun's Position* at the time of the Question, and may be measured either by turning of the *Quadrant of Altitude* to the contrary side of the *Meridian*, and counting thereupon the *Complement* of the side **E. Z.** 42 deg. 48 min. and the *Complement* of the side **Z. P.** 20 deg. upon the *Colure*; and the distance of these two Points shall be the measure of the Angle **Z. E. P.** which will be found to contain 36 deg. 52 min. Or you may turn the *Triangle*, and place **Z. E.** in the place where before **Z. P.** was placed, and then may that Angle be measured upon the *Equinoctial* between the *Colure* and the *Brass Meridian*, as the Angle **Z. P. E.** was.

The Angle

The

The several *Sides* and *Angles* of this *Triangle* being discovered, I will now come to shew the several *Cases* which will arise out of this, and every *Oblique Spherical Triangle*: But first let me shew you

How to express the Triangle upon the Globe.

Elevate the *Pole* of the *Globe* to the *Complement* of any of the *Sides* of the *Triangle*, as in this *Example*, to 51 deg. 30 min. (which is the *Complement* of the *Side* Z. P.) then count the *Side* Z. P. 38 deg. 30 min. from the *Pole*, and thereto screw the *Quadrant of Altitude*. This done, count the *Side* E. P. 70 deg. upon the *Equinoctial Colure* from the *Pole*, and the *Side* Z. E. upon the *Quadrant of Altitude* from the *Zenith* downward, and so move the *Globe* and *Quadrant of Altitude* together, till the numbers counted upon both of them concur in one *Point*; and so shall you have your *Triangle* exactly delineated upon the *Globe*; which being done, I proceed to the *Six Cases* of *Oblique-angled Spherical Triangles*, and to shew the *Variety* of *Problems* that will naturally arise out of the solving of every such *Oblique Triangle*.

H 3

CASE I.

CASE I.

The Side Z. P. 38 deg. 30 min. The Side
E. P. 70 deg. and the Side Z. E. 47 deg.
12 min. being given, to finde the Angles,

E Levate the Globe to the 51 deg. 30 min. the Complement of Z. P. and count the Side Z. P. the Complement of the Latitude 38 deg. 30 min. from P. to Z. and there fasten the *Quadrant of Altitude*. Then count the Side E. P. the Complement of the Sun's declination 70 deg. upon the *Colure* from the Pole downwards: Also count the Complement of the Sun's Altitude 47 deg. 12 min. The Side Z. E. upon the *Quadrant of Altitude* downwards; and move the Globe and *Quadrant* together till 70 deg. of the *Colure*, and 47 deg. 12 min. of the *Quadrant* do meet: So is your Triangle represented upon the Globe.

Now to finde the several Angles. (1.) For the Angle at Z. count the number of degrees of the *Horizon*, which are contained between the North-part of the *Meridian*, and the *Quadrant of Altitude*; and you shall finde them to be 115 deg. 35 min. and that is the quantity of the Angle E. Z. P. and is the Sun's *Azimuth* from the North-part of the *Meridian*. (2.) For the Angle Z. P. E. count the number of degrees of the *Equinoctial*, which are contained between the South-part of the *Meridian* and the *Colure*; which you will finde to be 45 deg. and that is the quantity of the Angle

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gle Z. P. E. which is the hour from Noon, namely 9 in the Morning, or 3 in the Afternoon-
(3) For the Angle Z. E. P. (either change the Triangle by elevating the Globe anew, or) count 42 deg. 48 min. the Complement of Z. E. upon the Quadrant of Altitude (it being brought to the other side of the Meridian) and also count the 20 deg. the Complement of E. P. upon the Colure (on the other side of the Meridian) the distance between these two points, measured by Compasses or otherwise, will be found to contain 36 deg. 52 min. equal to the Angle Z. E. P. which is the Angle of the Sun's or Stars position at the time of the Question.

And thus by this one Data, you have resolved three Problems: For you have found

1. The Angle E. Z. P. the Sun's Azimuth 115 deg. 35 min.
2. The Angle Z. P. E. the hour 45 deg. or 9, or 3 a clock.
3. The Angle Z. E. P. the Sun's Angle of position 36 deg. 52 min.

CASE

CASE II.

The two Sides E. Z. 47 deg. 12 min. Z. P. 38 deg. 30 min. and the Angle comprehended between them being given, to finde the other parts of the Triangle.

COUNT P. Z. 38 deg. 30 min. (the Globe being elevated to the Complement thereof) upon the Meridian, from P. to Z. and there fix the *Quadrant of Altitude*: Then from the North-part of the Meridian upon the Horizon, count the quantity of the Angle E. Z. P. 115 deg. 35 min. and thereto bring the *Quadrant of Altitude*: Then count the other given Side E. Z. 47 deg. 12 min. upon the *Quadrant of Altitude* downwards; and turn the Globe about till the Equinoctial Colure cut the *Quadrant of Altitude* in 47 deg. 12 min. So is your Triangle delineated upon the Globe.

Now to finde the several Parts: (1.) The degrees of the Colure contained between the Pole and the *Quadrant* being 79, is the Side E. P. (2.) The degrees of the Horizon between the Meridian and *Quadrant*, being 115 deg. 35 min. is the Angle E. Z. P. And (3.) The distance between the Complement of E. Z. upon the *Quadrant of Altitude*, and the Complement of E. P. upon the Colure (they being both continued to *Quadrants*, on the other Side of the Meridian) will be found 36 degrees 52 minutes, which is the Angle Z. E. P.

Thus

Thus by this *Data* you have found

1. E. P. The Complement of the *Sun's Declination*.

2. E. Z. P. The *Sun's Azimuth* from the North.

3. Z. E. P. The Angle of the *Suns or Stars Position*.

But if the *Sides* Z. P. P. E. and *Angle* Z. P. E. had been given, there would then have been found

4. P. E. Z. The *Angle of Position*.

5. E. Z. The Complement of the *Sun's Altitude*.

6. E. Z. P. The *Azimuth* from the North.

Or if the *Sides* Z. E. P. E. and *Angle* Z. E. P. had been given, there would then be found

7. E. Z. P. The *Sun's Azimuth* from the North.

8. Z. P. The Complement of the *Latitude*.

9. Z. P. E. The *Hour* from Noon.

CASE

CASE III.

The two Angles E. Z. P. 154 deg. 25 min.
and Z. P. E. 45 deg. with the Side Z. P. 38
deg. 30 min. comprehended between them,
given, to finde the other parts of the
Triangle,

COUNT 38 deg. 30 min. the Side Z. P. upon
the Meridian from the Pole, and thereto
screw the Quadrant of Altitude; then count 45
deg. the Angle Z. P. E. upon the Equinoctial, (be-
ginning at the Colure) and bring those 45 deg.
to the South-part of the Brass Meridian. Again,
count 115 deg. 35 min. the Angle E. Z. P. upon
the Horizon, from the North-part of the Meri-
dian, and thereto bring the Quadrant of Altitude.
And so have you represented your Triangle upon
the Globe.

Now to finde the other Sides, and Angle,
(1.) The degrees contained between the Pole and
the Colure, upon the Quadrant; namely, 47 deg.
12 min. will be the Side Z. E. (2.) And the
degrees between the Pole and the Quadrant upon
the Colure, viz. 70, will be the Side E. P. (3.)
Add the distance between the Complements of
the Sides E. Z. and E. P. being continued to Qua-
drants on the other Side of the Meridian; name-
ly, 36 deg. 52 min. will be the Angle Z. E. P.

And

And by this *Data*, you have found

1. $Z. E.$ The Complement of the *Sun's* *Altitude*.
2. $E. P.$ The distance of the *Sun* from the *Pole*.
3. $Z. E. P.$ The Angle of the *Sun's* *Position*.

But if the *Side* $E. P.$ and the *Angle* $Z. E.$ $P.$ and $Z. P. O.$ had been given, there would have been found

4. $E. Z.$ The Complement of the *Sun's* or *Stars* *Altitude*.
5. $E. Z. P.$ The *Sun's* or *Stars* *Azimuth* from the *North*.
6. $Z. P.$ The Complement of the *Latitude*.
And if the *Side* $Z. E.$ and the *Angle* $P. Z. E.$ and $P. E. Z.$ had been given, you might then find
7. $Z. P.$ The Complement of the *Latitude*.
8. $Z. P. E.$ The *Hour* from *Noon*.
9. $P. E.$ The Complement of the *Sun's* or *Stars* *Declination*.

CASE

CASE IV.

The two Sides Z. P. 38 deg. 30 min. and
E. P. 70 deg. with the Angle Z. E. P.
36 deg. 52 min. being given, to find
the other Side and Angles.

TO resolve this Case, you may (if you please)
revert the Triangle, by elevating the Globe
19. 20 deg. the Complement of the given Side
P. E. then counting 70 deg. the Side E. P. upon
the Meridian from the Pole, there screw the Qua-
drant of Altitude. Then upon the Horizon,
count 36 deg. 52 min. the given Angle E. and to
them bring the Quadrant of Altitude. So have
you fixed the Angle Z. E. P. Then turn the Globe
about, till 38 deg. 30 min. the other given Side
P. Z. do touch the Quadrant, which it will do in
47 deg. 12 min. for the Side E. Z. And for the
Angle P. the degrees of the Equinoctial between
the Meridian and the Colure, viz. 45, is the An-
gle at P. and for the Angle at Z. it may be found
by reverting of the Triangle again, or by the
Complements of the Sides extended on the other
side of the Meridian, as hath been before taught.
Lastly, for the Side E. Z. you have it upon the
Quadrant 47 deg. 12 min.

The Triangle being thus delineated, you have
found (1.) the Side E. Z. 47 deg. 12 min. (2.)
the Angle P. 45 deg. (3.) the Angle E. Z. P. 154
deg. 25 min.

I thought good in this place to insert this manner of Change, not only for variety, but because in this and the next Case the Triangle may be more readily delineated upon the Globe.

And in this one Data you have found

1. E. Z. The Complement of the Sun's Altitude.
2. Z. P. E. The hour from Noon.
3. E. Z. P. The Azimuth of the Sun or a Star from the North.

But if the Sides Z. P. and E. P. and the Angle E. Z. P. had been given, you would then have found

4. E. Z. The Complement of the Sun or Stars Altitude.
5. Z. E. P. The Angle of the Sun or Stars Position.

6. Z. P. E. The hour from Noon.
And if there had been given E. P. E. Z. and E. Z. P. then would have been found

7. Z. P. The Complement of the Latitude.
8. Z. P. E. The hour from Noon.
9. Z. E. P. The Angle of Position.

In like manner, if P. E. E. Z. and Z. P. E. had been given, you would have found

10. Z. P. The Complement of the Latitude.
11. E. Z. P. The Azimuth from the North.
12. Z. E. P. The Angle of Position.

Again, if there had been given E. Z. Z. P. and Z. P. E. you might then find

13. P. E. The Sun's distance from the Pole.
14. Z. E. P. The Angle of Position.
15. E. Z. P. The Azimuth from the North.

Lastly,

Lastly, If $E. Z.$ and $Z. P.$ and the Angle $Z. E. P.$ had been given, there would have been found

16. $P. E.$ The Complement of the *Sun's* or *Stars* declination.

17. $Z. P. E.$ The *hour* from Noon.

18. $E. Z. R.$ The *Azimuth* from the North.

CASE V.

The two Angles $E. Z. P.$ $115^{\circ} 35'$.
 $Z. P. E.$ 45° deg. with the Side $P. E.$ 70
 deg. being given, to find the rest of the
 Triangle,

E Levate the *Globe* to 20° deg. the Complement of the Side $E. P.$ Then count the given Side $E. P.$ 70° deg. upon the *Meridian*, from $P.$ to $Z.$ and there fix the *Quadrant*. Then the given Angle $E. P. Z.$ being 45° deg. count 45° deg. upon the *Equinoctial* from the *Colure*, and bring that point under the *Meridian*. So have you constituted the Side $E. P.$ and the Angle $E. P. Z.$ Now for the Angle $E. Z. P.$ you must either reverse the Triangle again, or find it by the Complements of the Sides $Z. E.$ and $Z. P.$ extended to *Quadrants* on the other side of the *Meridian*, which you shall find to be $115^{\circ} 35'$.

The Triangle thus constituted, (1.) For the Side $Z. P.$ the degrees of the *Colure* between the *Pole* and the *Quadrant* being $38^{\circ} 30'$. is that Side. (2.) The degrees of the *Quadrant* of *Altiude*, between the *Zenith* and the *Colure*, being

being 47 deg. 12 min. is the Side E. Z. (3.) The degrees of the Horizon between the Meridian and the Quadrant of Altitude being 36 deg. 52 min. is the quantity of the Angle Z. E. P.

By which single Data, you have found

1. Z. P. The Complement of the Latitude.

2. E. Z. The Complement of the Altitude.

3. Z. E. P. The Angle of Position.

But if the Angles E. Z. P. Z. R. E. and the Side Z. E. had been given, then might you finde

4. Z. P. The Complement of the Latitude.

5. P. E. The Sun's distance from the Pole.

6. Z. E. P. The Angle of Position.

Or had there been given Z. P. E. Z. E. P. and the Side E. P. you might from thence finde

7. Z. P. The Complement of the Latitude.

8. E. P. The Complement of the Sun or Stars declination.

9. E. Z. P. The Sun's Azimuth from the North.

And if the Angles Z. P. E. Z. E. P. with the Side Z. P. had been given, then would have been found

10. Z. E. The Complement of the Sun's Altitude.

11. P. E. The Sun's distance from the Pole.

12. E. Z. P. The Sun's Azimuth from the North.

But if the Angles Z. E. P. E. Z. P. and the

the Side $Z. P.$ had been given, then you might finde

13. $Z. E.$ The *Suns* distance from the Zenith.

14. $P. E.$ The *Suns* distance from the Pole.

15. $Z. P. E.$ The *hour* from Noon.

And lastly, had there been given the *Altitudinal gler* $Z. E. P.$ $E. Z. P.$ and the Side $P.$ $E.$ then might be found

16. $Z. E.$ The Complement of the *Suns* or *Suns* *Altitude*.

17. $Z. P.$ The Complement of the *Latitude*.

18. $Z. P. E.$ The *hour* from Noon.

CASE VI.

The three Angles $E. Z. P. 115^{\circ} 35'$ min.
the Angle $E. P. Z. 45^{\circ}$ and the Angle $Z. E. P. 36^{\circ} 52'$ min. being given, to finde the three Sides.

THis Case may best be resolved by turning the Angles of the Triangle into Sides, as shall be taught by and by: and so by this Data, you may finde

- 1. $Z. E.$ The Complement of the *Suns* *Altitude*
- 2. $Z. P.$ The Complement of the *Latitude*.
- 3. $E. P.$ The Complement of the *Suns* *declination*.

And thus have you out of this one *Oblique Spherical Triangle*, by the variety that these Six Cases afford, no less than *Threescore Problems* resol-

Trigonometrical Problems.

resolved, viz. 3 in the *First Case*, 9 in the *Second Case*, 9 in the *Third Case*, 18 in the *Fourth Case*, 18 in the *Fifth Case*, and 3 in the *Sixth Case*; in all 60. And so many *Varieties* or *Changes* are there in every *Oblique-angled Spherical Triangle*. — And besides these *Varieties*, this *Triangle ZEP*. is not peculiar only to the appellations that I have here given them, but to other purposes also. For,

This *Oblique-angled Triangle* is not capable only of resolving the forementioned *Astronomical Questions*, but may be applied to *Geographical* or *Nautical Questions* also. For,

1. The *Side ZP*, may represent the *Complement* of the *Latitude* of that *Town* or *Citie* whose *Zenith-point* is *Z*.
2. The *Side EZ*, may represent the *distance* between those two *Cities* or *Towns*.
3. The *Side PE* will be the *Complement* of the *Latitude* of that *City* or *Town* at *E*.
4. The *Angle EPZ*, is the *difference of Longitude* between the two *places E* and *Z*.
5. The *Angle PZE*, the *Point* of the *Compass* leading from *Z* to *E*.
6. The *Angle PEZ*, the *Point* of the *Compass* leading from *E* to *Z*.

And in this *Triangle* the same things being given, they may be *varied* as before, and afford as many *Questions* in *Geography* or *Navigation* as in *Astronomy*: Namely 60.

Moreover, In the same *Triangle*, if you imagine the

the Side PZ to be 23 deg. 30 min. the distance of the Pole of the *World*, from the Pole of the *Ecliptick*: Then will

1. The Side ZP , be the distance of the Pole of the *World* from the Pole of the *Ecliptick*.
2. The Side PE will be the Complement of the declination of a Star at E .
3. The Side ZE , will be the Northern Latitude of the Star at E .
4. The Angle EPZ , will be the Complement of the Stars Right Ascension.
5. The Angle PZE , is the quantitie of the Stars Longitude.
6. The Angle PEZ , is the Angle of the Stars Position.

And this way it will afford 60 Varieties more, as is before intimated.

Theorem.

Theorem.

The Sides of any Spherical Triangle, may be turned into Angles ; & contra, the Complement of the Greatest Side, or Greatest Angle (to a Semicircle) being taken for the Greatest Side, or Greatest Angle.

Demonstration.

Let ABC, be a Spherical Triangle Obtuse angled at B. And let

DE } be the Measure { A
HI } of the Angle { C
GF } { B viz. of its Comple-
ment, FBG, it being the Angle of the Triangle.

Now,

KL }
LM } is equal to { DE
KM } { FG
 { HI

Because

KD } { LE } are Quadrants, and { LD
LG } { FM } their Common { LF
KI } { MH } Complement is { KH.

Therefore,

The Sides of the Triangle KLM, are equal to the Angles of the Triangle ABC, taking for the Greatest Angle ABC, the Complement thereof FBG.

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Trigonometrical Problems.

It may also be *demonstrated*, That the *Sides* of the Triangle *A B C*, are equal to the *Angles* of the Triangle *K L M*, by the converse of the former. For

The side $\left\{ \begin{array}{l} A B \\ B C \\ A C \end{array} \right\}$ is equal to $\left\{ \begin{array}{l} O P \\ F H \\ D I \end{array} \right\}$ the measure of the Angle $\left\{ \begin{array}{l} M L K \\ L M K \\ D K I \end{array} \right\}$ of the Complement of the Obtuse Angle *D K I*.

For,

$\left\{ \begin{array}{l} A D \\ A P \\ B F \end{array} \right\}$ and $\left\{ \begin{array}{l} C I \\ O B \\ C H \end{array} \right\}$ are Quadrants, & their Common Complement is $\left\{ \begin{array}{l} C D \\ A O \\ C F \end{array} \right\}$.

Therefore, *The Sides may be turned into Angles, and the contrary; which was to be demonstrated. And by this Conversion, may the 5th Case of Right, and the 6th Case of Oblique Spherical Triangles be resolved.*

How a Perpendicular is to be let fall in any Oblique Spherical Triangle, thereby dividing it into two Right-angled Triangles.

THis Problem is not of any Use in the Solution of Triangles by the Globe, as is evident by

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by what hath been already delivered concerning the Solving of them: But for that in *Trigonometrical Calculations*, there is a necessity for so doing, and the doing of it no less difficult to conceive or imagine; and seeing how naturally, and lively it is represented upon the *Globe*, I will therefore here insert it. And it is grounded upon the First *Theorem* at the beginning of this Tract of *Trigonometry*. *Viz.*

If two Great Circles of the Sphere shall pass through each others Poles, those two Circles shall cut each the other at Right Angles.

In the *Oblique-angled Triangle* Z E P, before made use of, let there be given, (1.) the *Side* P Z. (2.) The *Side* E Z, and (3.) The *Angle* E P Z. and let it be required to finde the *Side* P E. This *Problem* is done by the *Globes*, by the 4th *Case*, as you may there see, without the help of any *Perpendicular*; but in *Calculation* it is wholly necessary, and therefore may well deserve the place of a *Problem* here.

The *Triangle* being described upon the *Globe*, let it be required to let fall a *Perpendicular* from the *Angle* Z, upon the *Side* E P: The Measure of the *Given Angle* P, being upon the *Equinoctial*, see upon the *Globe* where the *Side* P E (being extended) cuts the *Equinoctial*, and from that Point count 90 degrees upon the *Equinoctial*, and that Point shall be the *Pole* of the *Circle* (P E.) (For the *Poles* of all *Great Circles* are a *Quadrant*, or 90 degrees distant from their *Peripheries*:) wherefore the *Quadrant* of *Altitude* being fixed

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in Z, bring it to this Point found in the *Equinoctial*, and then will it cut the *Side EP* in the Point where the *Perpendicular* must fall, which will be at K, 29 degrees 21 minutes distant from P.

CONCLUSION.

IN the foregoing *Precepts*, I have made use only of two *Triangles* for the Solution of the *Five Cases* of *Right*, and the *Six Cases* of *Oblique-angled Spherical Triangles*; namely, of the *Triangle P ⊙ ⊙* for *Right-angled*, and *ZEP* for *Oblique-angled*. Yet in the Figure of the *Globe* by the intersection of the several *Circles* thereof, there are divers other *Triangles* (both *Right* and *Oblique*) constituted, all which the foregoing *Rules* and *Cases* will sufficiently *Solve*. A few of the Principal I will mark in the *Globe* by numerical *Figures*, for distinction, and give you an account of what *Circles* they are composed, and what *Questions* of the *Globe* are *Resolvable* thereby.

The *Triangle* that I have made use of for *Right-angled Triangles*, viz. *P ⊙ O*, I have marked with the Figure 1. And the *Oblique Triangle ZEP*, with the Figure 2; and shall say no more of them, having sufficiently dealt with them already; but come to give you an account of such other as I have marked in the Figure. And

The first that I shall take notice of is, the *Triangle AKM*, marked with the Figure 3. *Right-angled*

angled at M, which is constituted of

A K an Arch of the Equinoctial.

A M an Arch of the Ecliptick, and

K M an Arch of a Circle of Longitude passing through the Poles of the Ecliptick.

In this Triangle,

The Side A M, is the Suns or a Star's Longitude, or distance from the Equinoctial Point A.

The Side { K M is the South Latitude of a Star at M,
or the Suns South declination.
A K is the Right Ascension.

The Angle { K A M is the Suns greatest declination.
A K M, the Angle the Circle of Longitude makes with the Equinoctial.
A M K is a Right Angle.

The Second Triangle that I shall take notice of is A \odot B, Right-angled at B, and marked with the Figure 4; and which is constituted of

A \odot , an Arch of the Horizon.

A B, an Arch of the Equinoctial, and

B \odot , an Arch of a Meridian or Hour-circle.

In this Triangle,

The Side { A \odot is the Amplitude of the Suns Rising or Setting from A, the East or West Points of the Horizon.
B \odot is the Suns declination North.
A B is the Ascensional difference.

The Angle

- $\left\{ \begin{array}{l} \odot B A \text{ is a Right Angle.} \\ \odot A B \text{ is the Complement of the Latitude.} \\ A \odot B \text{ is the Angle of the Suns Position at his Rising.} \end{array} \right.$

The third *Triangle* that I here take notice of, is the *Triangle* A L F, Right-angled at F, and marked with the Figure 5. The which is constituted of

- A L, an Arch of the *Equinoctial Colure*.
 A F, an Arch of the *Horizon*, and
 L F, an Arch of an *Azimuth* or *Vertical-Circle*.

In this *Triangle*

The side

- $\left\{ \begin{array}{l} A F \text{ is the Suns Azimuth being East or West.} \\ A L \text{ is the Suns Declination North.} \\ L F \text{ is the Suns Altitude at Six a clock.} \end{array} \right.$

The Angle

- $\left\{ \begin{array}{l} L F A \text{ is a Right Angle.} \\ L A F \text{ is the Latitude.} \\ A L F \text{ is the Angle of Position.} \end{array} \right.$

The fourth and last *Triangle* that I shall mention, is A D C, Right-angled at C, and marked with the Figure 6, and is composed of

- A D, an Arch of the *Prime Vertical-Circle*, or
Azimuth of East or West.
 A C, an Arch of the *Equinoctial*.
 D C, an Arch of a *Meridian* or *Hour-circle*.

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In which Triangle,

The Side { AD is the *Sun's Altitude* when he is due
East or West.
AC is the *Ascensional difference*.
DC is the *Sun's Declination North*.

The Angle { ADC is a *Right Angle*.
CDA an *Angle of Position*.
DAC is the *Latitude*.

Thus have you an account of *Four* other *Right-angled Spherical Triangles*, with the *Affections* or *Natures* of their *Respective Sides* and *Angles*; out of each of which, by the *Varieties* that will arise from the *Five Cases*, may be deduced 30 *Problems*, and in all the *Four Triangles* 120 *Problems*, all which may be performed according to the *Directions* of the *Five Cases* of *Right-angled Spherical Triangles*; the *Exercising* whereof I leave to the *Practitioner*. — There are divers other *Triangles* may be found both *Right* and *Oblique-angled*, but these as the principal I commend to the *Practice* of the young *Tyro*.

HORO-

MOROLOGIOGRAPHICAL Problems.

INTRODUCTION.

*Of the distinction of Plains, upon which
Dials are to be made.*

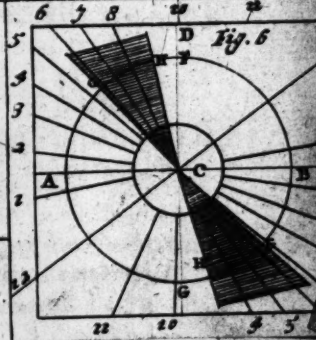
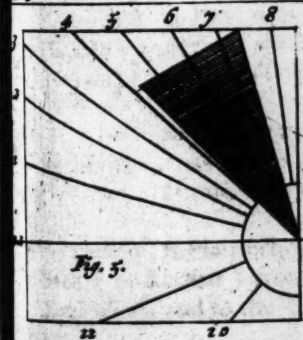
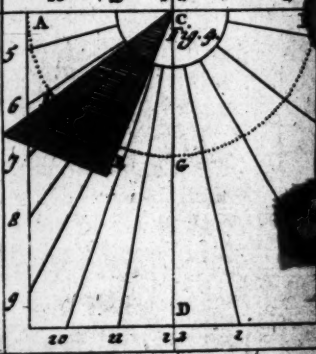
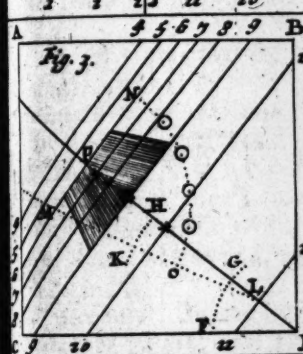
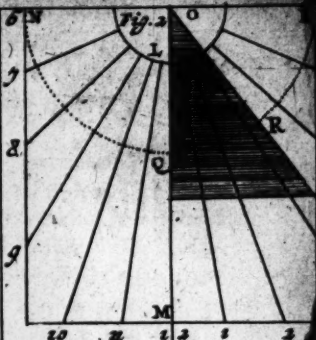
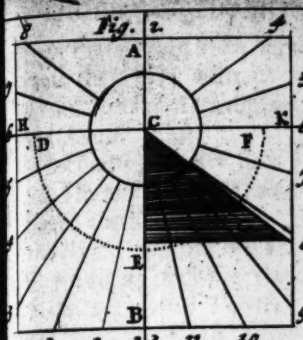
AL Plains upon which *Dials* are made, in any *Latitude* or part of the World, do either lie 1. *Parallel* to the *Horizon*, or 2. are *Perpendicular* to the *Horizon*, or 3. do cut the *Horizon* at *Oblique Angles*: and of these sorts of Plains there are several *Varieties*, excepting the first.

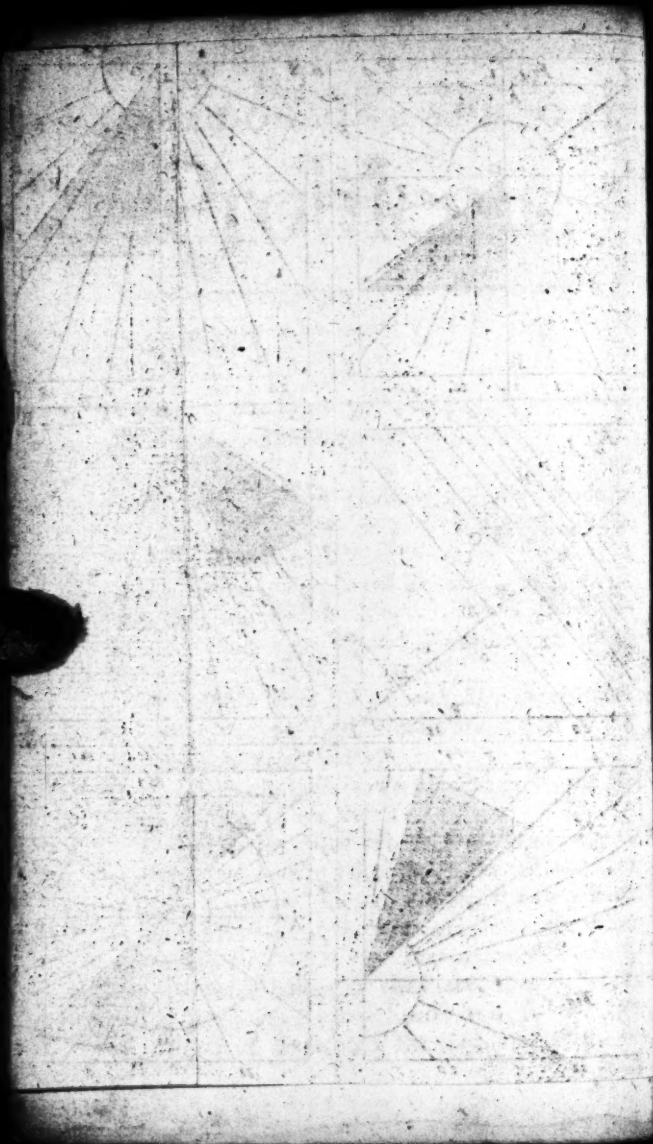
1. A Plain that lieth *Parallel* to the *Horizon*, is said to be an *Horizontal Plain*; and of this kinde there is no Variety.

2. Of Plains that are *Perpendicular* to the *Horizon* there are Two Varieties: For,

First, If the Plain which is *Perpendicular* to the *Horizon*, do stand directly in the *Azimuth*, or *Vertical Circle*, of *East* and *West*, the two Faces thereof beholding one the *South*, and the other the *North* — Or if the *Perpendicular* Plain do stand in the *Meridian* of the Place, that is, in the *Azimuth* of *North* and *South*, and so the two Faces thereof do behold the *East* and *West* —

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Such Plains are called *direct Vertical Plains*, because they have a direct respect to the four Cardinal Points of Heaven, viz. the *East, West, North, and South*. But

Secondly, If any such *Perpendicular Plain* do stand in any other *Azimuth* or *Vertical-Circle* between the *South* and the *East*, or the *North* and the *West*, so that one Face beholdeth the *South-East*, and its opposite the *North-West*; then these Plains are called *Vertical Plains declining* from the *North* or *South*, towards either the *East* or *West*.

3. Of Plains that cut the *Horizon* at *Oblique Angles*, and yet do lie directly in the prime *Vertical Circle*, or *Azimuth* of *East* or *West*, there are six Varieties. For

First, A plain beholding the *South*, may fall back, (or Recline) from the *Zenith*, just into the *Pole*, and then will the Plain lie *Parallel* to the *Axis* of the *World*, and such a Plain is called a *Polar Plain*.

Secondly, It may so fall back (or Recline) from the *Zenith*, that it may fall between the *Zenith* and the *Pole*, or between the *Pole* and the *Horizon*; and these three sorts are called *South Reclining Plains*.

Reclining
{

 equal to
 less than
 more than

 the *Pole* or *Co-Latitude*
 of the *Place*.

Thirdly, A Plain beholding the *North*, may fall back (or Recline) from the *Zenith* equal to the *Equinoctial*, and so the Plain will lie *parallel* to the

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the *Equinoctial Circle*, and is therefore called an *Equinoctial Plain*.

Fourthly, It may so fall back (or Recline) that it shall rest between the *Zenith* and the *Equinoctial*, or between the *Equinoctial* and the *Horizon*; and these three sorts are called *North-reclining Plains*.

Reclining $\left\{ \begin{array}{l} \text{equal to} \\ \text{less than} \\ \text{more than} \end{array} \right\}$ the *Equinoctial*,
or *Latitude* of
the *Place*.

Fifthly, Of Plains that cut the *Horizon* at *Oblique Angles*, and do lie directly in the *Meridian* or *Azimuth* of *North* and *South*, there is only one Variety: for all such Plains will fall between the *Zenith*, and the *East* or *West*-points of the *Horizon*; and so are called *East* or *West Recliners*.

Sixthly, Of Plains that cut the *Horizon* at *Oblique Angles*, and do not lie in the prime *Vertical-Circle* or *Azimuth* of *East* and *West*, but in some other intermediate *Azimuth* or *Vertical-Circle* between the *South* and the *East* or *West*; there are also of those six Varieties: — And of these, those that behold the *South*, are called *South-Recliners*, declining *East* or *West*: — And those that behold the *North*, are called *North-Recliners*, declining either *East* or *West*.

Now

Now of these six sorts, all Plains besides the forementioned must necessarily be one of these following : For,

1. The South Reclining Plain, by reason of its Declination, may so chance as to fall
 - Just into the Pole-point, and so is called a *Polar declining Plain*.
 - Between the Zenith and the Pole.
 - Between the Pole and the Horizon.

And these are called *South Declining Plains*.

Reclining $\left\{ \begin{array}{l} \text{equal to} \\ \text{less than} \\ \text{more than} \end{array} \right\}$ the Pole.

2. The North Reclining Plain, by reason of its Declination, may so chance as to fall
 - Just at the Intersection of the Meridian with the Equinoctial.
 - Between the Zenith and Equinoctial.
 - Between the Horizon and the Equinoctial.

And these are called *North Declining Plains*.

Reclining $\left\{ \begin{array}{l} \text{equal to} \\ \text{less than} \\ \text{more than} \end{array} \right\}$ the Equinoctial.

Seventhly, All Plains that do Decline and Recline also, have their opposite Faces, and those are called *North or South Declining Inclining Plains*; and the same Dial that serves for a *South Declining Reclining Plain*, will serve also for a *North Declining Inclining Plain*.

And

And *Dials* upon any of these Variety of Plains may be made by the *Globes*, as I shall come now to shew.

PROB. I.
To make an Horizontal Dial in any Latitude.

I. The Operation by the Globe.

Elevate the *Globe* to the *Latitude* of the place for which you would make your *Dial*, (suppose for *London*, in the *Latitude* of 51 deg. 30 min.) Then bring the *Vernal Equinoctial Colure* (which is the first point of *Aries* also) to the *Meridian*, and (if you will) the *Index* of the *Hour-Circle* to 12. This done,

1. Turn the *Globe* about *Westward*, till the *Hour-Index* points at 1 a clock, or rather [till 15 degrees of the *Equinoctial* come to be just under the *Meridian*,] and there keeping the *Globe*, look upon the *Horizon* how many degrees thereof are cut by the *Equinoctial Colure*; which you shall finde to be 11 deg. 50 min. which set down in a little Table, as you see here is done; for this 11 deg. 50 min. is the distance that the *hour-lines* of 11 and 1 a clock are distant from the *Meridian* upon the *Dial Plain*.

		d.	m.
Latitude 51. 30			
12		00.	00
11	1	11.	50
10	2	24.	20
9	3	38.	3
8	4	53.	35
7	5	71.	6
6		90.	0

2. Turn the *Globe* more *Westward*,

ward, till 30 degrees of the *Equinoctial* comes to the *Meridian*, and then see what degrees of the *Horizon* are cut by the *Equinoctial Colure*, which you will finde to be 24 deg. 20 min. which note down in a Table as before, for that is the *hour* distance of 10 and 2 a clock from the *Meridian*.

3. Turn the *Globe* still more *Westward*, till 45 degrees of the *Equinoctial* come to the *Meridian*, and then shall the *Equinoctial Colure* cut 38 deg. 3 min. of the *Horizon* counted from the *Meridian*, which is the distance of 9 and 3 a clock.

Do thus with the other hours of 8 and 4, of 7 and 5, and so shall the *Colure* cut 90 degrees at 6 a clock, or when 90 degrees of the *Equinoctial* comes to the *Meridian*. And this being done, your *Dial* is so far made as the *Globe* can assist you. Now for

II. The Geometrical Construction of this Dial.

FIG. I.

1. Upon the Plain on which you designe to draw your *Dial*, draw a Right line A B, representing the *Meridian* of your *Globe*, and the Hour-line of 12 of the clock.

2. Assigne towards one end of this Line a point as C, representing the Centre of your *Dial*, and through that Point draw another Line at Right angles to A B, which shall be the Hour-line of 6 a clock, as the Line H K; and upon the Point C, describe a Semicircle D E F, according to the Radius of some Line of *Chords*. Then

If you know not what a Line of Chords is, or know not how to use it, read my Geometrical Exercises lately printed.

1. Laying your little Table (before made) before you, you find *Latin*. 51 deg. 30 min. Take 51 deg. 30 min. from your Line of Chords, and set that distance upon the Semicircle from E to G, and draw the Line CG for the Stile or Cock of your Dial.

2. Then seeing that 11 and 1 a clock are distant from the Meridian 11 deg. 50 min. take 11 deg. 50 min. from your Chord, and set it upon the Semicircle from E to 11, and from E to 1, and draw the Lines C 11, and C 1, for the Hour-lines of 11 and 1.

3. The distance of 10 and 2 a clock being 24 deg. 20 min. take 24 deg. 20 min. out of your Line of Chords, and set it upon the Semicircle from E to 10, and from E to 2, and draw the Lines C 10, and C 2, for the Hour-lines of 10 and 2.

4. Do thus with the rest of the Hour-lines of 9 and 3, 8 and 4, — 7 and 5. So have you all the Hour-lines between 6 in the morning and 6 at night; and for the Hour-lines of 4 and 5 in the morning, and of 7 and 8 at night, draw the same Hour-lines before 6 through the Centre, as in the Figure, and they shall be the true Hour-lines: And so is your Dial finished.

The Stile must stand upright upon 12 of the clock, not inclining on either side.

PROP.

PROB. II.

To make a Vertical South Dial.

I. The Operation by the Globe.

The Globe being set to the Latitude, and the Quadrant of Altitude in the Zenith,

1. Bring the Equinoctial Colure to the Meridian, and (if you will) the Index of the Hour-wheel to 12.

2. Turn the Globe about Westward, till 15 degrees of the Equinoctial be under the Meridian, then shall the Equinoctial Colure cut 9 deg. 28 min. of the Horizon counted from the Meridian; and that is the Hour-distance of 11 and 1 a clock from 12.

Comp. of the
Latit. 38. d. 30 m.

		d. m.
12		00.00
11	1	9.28
10	2	19.45
9	3	31.54
8	4	47. 9
7	5	66.42
6		90.00

3. Turn the Globe more Westwardly, till 30 degrees of the Colure be under the Meridian, then shall the Colure cut upon the Horizon 19 deg. 45 min. which is the distance of 10 and 2 a clock from 12.

4. Turn the Globe still Westwardly, till 45 deg. 60 deg. and 75 deg. come under the Meridian; and so shall you finde that the Colure will cut the Horizon in 31 deg. 54 min. for 9 and 3 a clock, and the rest, as in this Table. And so is the Globular work of your Dial finished.

II. The Geometrical Construction of this Dial.

FIG. II.

1. Draw a Right Line L M upon your Plain for the *Meridian*, and *Hour-line* of 12; and another *Perpendicular* thereto, as N P for the *Hour-line* of 6 and 6; and where these Lines cross (as at O,) is the Centre of your *Dial*.

2. Upon O, as a Centre, with the Radius of a Line of *Chords*, describe a Semicircle N Q P, and then taking 38 deg. 30 min. (which is the Complement of the *Latitude* of the place) out of the Line of *Chords*, set it from Q to R, and draw the Line O R for the Cock or Stile of your *Dial*.

3. Laying your Table before you against 11 and 1 of the clock, you finde 9 deg. 28 min. Take therefore 9 deg. 28 min. out of your *Chord*, and set that distance upon the Semicircle from Q to 11 and from Q to 1, and draw the Lines O 11 and O 1, for the Hour-lines of 11 and 1.

4. Also take 19 deg. 45 min. and set them from Q to 10, and from Q to 2, and draw O 10, and O 2, for the hours of 10 and 2.

5. Do the like for the hours of 9 and 3, 8 and 4, 7 and 5, and your *Dial* is finished.

The *Stile* must stand over 12, and must point downwards towards the *South-Pole*.

PROB.

PROB. III.

To make a Vertical direct North-Dial.

THE *North Vertical Dial*, is the same with the *South*, only the *Stile* must point upwards towards the *North-Pole*, and the hours about *Midnight*, as 9, 10, 11, 12: 1, 2, and 3 must be left out, and 4 and 5 in the Morning; and 7 and 8 at Night must be drawn through the Centre: So is your *North-Dial* finished.

PROB. IV.

To make a direct Vertical East or West Dial.

I. The Operation by the Globe.

THE *Globe* rectified to the *Latitude*, the *Index* to 12, the *Quadrant of Altitude* in the *Zenith*: If you turn the *Quadrant of Altitude* so about till the graduated edge thereof do behold the direct *East* or *West* points of the *Horizon*, you shall finde that it will lie in the very *Plain* of the *Meridian-Circle*, and so the *Pole* will have no elevation over it; for turning the *Globe* about, the *Equinoctial Circle* will not cut the *Quadrant of Altitude* in any particular degree, but it will

cut all the degrees thereof at the same time; wherefore the Hour-lines of these Plains will make no *Angles* at the *Pole*, and therefore must be parallel one to the other, which the *Globe* evidently demonstrates, but will not conveniently give the parallel distance of each from other, they being neerer or farther off of each other according as the *Stile* is proportioned to the Plain, which I shall now come to shew in

I I. The Geometrical Construction of these Dials.

FIG. III.

Let the Plain upon which you would make an *East* or *West Dial*, be A B C D.

1. Upon D (or any where towards the lower part of the Line B D, for an *East Dial*, or of A C for a *West*) with 60 degrees of your *Chord*, describe an Arch F G, upon which set the Complement of the *Latitude* of the place, viz. 38 deg. 30 min. from F to G, and draw the Line D G E for the *Equinoctial*.

2. Towards the upper part of this Line, as at P, assume any point, and through it draw the Line 6 P 6 perpendicular to the *Equinoctial*, for the Hour-line of Six. — Also, towards the lower part of the same Line, assume another point, as L, and through it draw the Line 11 L 11 for the Hour-line of Eleven.

3. With 60 degrees of your *Chords*, upon the point L, describe a small Arch of a Circle, as H K, and upon it (always) set 15 degrees (or one

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one hours distance) from H to K, and draw the Line L K M, cutting the Hour-line of Six in M.

4. Upon M as a Centre, with 60 degrees of your *Chord*, describe an Arch of a Circle N O, which divide into five equal parts in the points ○ ○ ○ ○.

5. Lay a Ruler upon M, and each of these points ○ ○ ○ ○, and the Ruler will cut the *Equinoctial-line* E D in the points * * * *, through which points, if you draw Right Lines parallel to the Hour-line of 6, they shall be the Hour-lines of 7, 8, 9, and 10 of the clock, the Hour-lines of 6 and 11 being drawn before.

6. For the Hour-lines of 4 and 5 in the Morning, before 6, they retain the same distance from 6, as do the hours of 7 and 8; and thus is your *Dial* finished.

The *Stile* must stand upon the Hour-line of 6, and be elevated so high as is the length of the Line M P, and may either be a pin of Wyre, or a plate of Brasse or Iron.

The *West-Dial* is the same with the *East*, only changing the names of the hours.

For

4, 5, 6, 7, 8, 9, 10, 11 in the morning, in the *East-Dial*;

Must be changed to

8, 7, 6, 5, 4, 3, 2, 1 in the afternoon, in the *West-Dial* :

Which is all the difference.

P R O B. V.

To make a Vertical Dial declining from the South, Eastward, or Westward; 30 degrees in the Latitude of 51 deg. 30 min.

I. The Operation by the Globe.

THe *Globe* being Rectified to the *Latitude* of the place, the *Quadrant of Altitude* in the *Zenith*, the *Index* of the *Hour-Circle* at 12, and the *Equinoctial Colure* brought under the *Meridian*;

1. Count the *Declination* of the *Plain* upon the *Horizon*, from the *East* or *West*-points thereof (according as the *Plain* declines) towards the *South* : namely, 30 degrees ; and to that point of the *Horizon* bring the *Quadrant of Altitude*, and there keep it.

2. Turn the *Globe* about till the *Index* of the *Hour-wheel* cuts 11 of the clock, or rather (as I said before) till 15 degrees of the *Equinoctial* have passed the *Meridian*, and then shall you finde the *Equinoctial Colure* to cut the *Quadrant of Altitude* at 9 deg. 50 min. if you count the degrees from the *Zenith* point downwards.

3. Turn the *Globe* farther about, till 30 degrees of the *Equinoctial* be past the *Meridian*, and then shall you finde the *Colure* to cut the *Quadrant*

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of *Altitude* at 18 deg. 14 min. counted from the *Zenith* downwards as before.

4. Do the like with all the rest of the hours, and you shall finde that at the several 15 degrees of the *Equinoctial*, the *Equinoctial Colure* will cut such degrees of the *Quadrant of Altitude* as are expressed in this Table, if you count them from the *Zenith* downwards, as is before directed.

Hours from Noon.		Hour-distances upon the Plain.	
		d.	m.
12		00	00
11	1	09	50
10	2	18	14
9	3	26	19
8	4	34	56
7	5	44	56
6	6	57	49
5	7	75	37

This done;

5. Bring the *Quadrant of Altitude* to the other side of the *Meridian*, and let it to 30 degrees, the *Plains* declination, counted from the *East* or *West* points *Northward*, as you did before towards the *South*, which will be in the just opposite point of the *Horizon* to which it was before; and also, bring the *Equinoctial Colure* under the *Meridian*. Then,

6. Turn the *Globe* about (the contrary way to what you did before) till 15 degrees of the *Equinoctial* be past the *Meridian*, and then shall you finde the *Equinoctial Colure* to cut at 12 deg. 23 min. of the *Quadrant of Altitude* counted from the *Zenith*.

And so continuing turning the *Globe* about till 30, 45, and 60 degrees of the *Equinoctial* have passed the *Meridian*, you shall finde the *Equinoctial Colure* to cut the *Quadrant of Altitude* at such degrees as are expressed in this Table.

Hours from Noon.		Hour-distances on the Plain.	
		d.	m.
12		00	00
1	11	12	28
2	10	29	19
3	9	52	42
4	8	80	07

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The Hour-distances upon the Plain being thus attained, there are two other requisites in all upright declining *Dyals* also to be found by the *Globe*, before the *Dyal* can be finished. Namely,

1. The distance of the *Substile* from the *Meridian*.
2. The height of the *Pole* above the *Plain*, or the height of the *Stile* above the *Substile*.

To finde both which,

Bring the *Equinoctial Colure* to the Plains declination 30 degrees counted upon the *Horizon* from the *South Eastward*; and the *Quadrant of Altitude* to 30 degrees counted in the *Horizon* from the *East Northward*: So shall the *Quadrant* cut the *Colure* at *Right Angles*. And

The number of degrees of the *Quadrant* contained between this *Interfection* and the *Zenith* (which here is 21 deg. 41 min.) is the distance of the *Substile* from the *Meridian*. And the degrees of the *Colure* contained between this *Interfection* and the *Pole* (which here is 32 deg. 37 min.) is the height of the *Pole* above the *Plain*.

II. *The Geometrical Construction.*

FIG. IV.

1. Draw a Line CD for the *Meridian* and Hour-line of 12, and at *Right Angles* thereunto draw

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draw another Line, as A B, for the *Horizontal-line*, crossing the former in the point C, the Centre of the *Dyal*.

2. Upon the point C, describe the *Semicircle* A G B.

3. Take 21 deg. 41 min. from your *Chord*, and (because the Plain declines *Eastward*) set it from G to E; also, take from your *Chord* 32 deg. 37 min. (which is the height of the Pole above the Plain) and set it from E to F, and draw the Line C E for the *Substile*, and C F for the *Stile* of the *Dyal*.

4. Having recourse to the Tables of Hour-distances, take 9 deg. 50 min. and set it from G to 11; also take 18 deg. 14 min. and set it from G to 10, and so the rest in that Table. — Also out of the other Table take 12 deg. 23 min. and set them from G to 1, &c.

5. From the Centre C draw Lines through the several points 5, 6, 7, 8, 9, 10, and 11; and also through 1, 2, 3, and 4, they shall be the true Hour-lines; and so have you finished this *Dyal*.

And in the making of this *Dyal*, you have made four *Dyals*; as I have intimated at large in my *Art of Dyalling*, Part 1. Chap. 7. For,

If you hold the Paper upon which the *South-East declining Dyal* is drawn, against the light, then shall you discover the *Stile* to stand on the *Right hand* of the Plain, whereas it now stands on the *Left hand*; so the same *Hour-lines*, *Substile*, *Stile* and all, being drawn on the back-side of the Paper, and those that are the *Forenoon-hours* in the *East-decliner* numbred as the *Afternoon-hours* in the *West-decliner*, that is, call 11, 1, and

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and 10, 2, and 9, 3, &c. as in the Tables; so shall the *South-Dyal* declining *East* 30 degrees, become a *South-Dyal* declining *Westward* 30 degrees.

And if you turn the *South-East-Dyal* upside-down, so that the *Stile* may point upwards towards the *North-Pole*, (and leave out the hours about 12, as 9, 10, 11, and 1, 2, and 3, which in *North-Dyals* represent 9, 10, and 11 at night, and 1, 2, and 3 in the morning; all which time (in those middle *Latitudes*) the *Sun* is under the *Horizon*) it will become a *North-Dyal* declining *Eastward* 30 degrees.

Also if you turn the *South* declining *West Dyal* upside-down, and leave out the hours about *Midnight*, as 9, 10, 11, 12, 1, 2, and 3, it will then become a *North-Dyal* declining *Westward* 30 degrees.

Now for such *South* or *North Dyals* as do decline far towards the *East* or *West*, as 60, 70, 80, or 85 degrees, there you shall finde that the hour-distances will fall so neer together, that they will be of no competent distance one from another, except they be extended very far from the Centre; and therefore the old way hath been (in such Cases) to draw the *Dyal* upon the Floor of a Room, extending the *Substile*, *Stile*, and *Hour-lines* till they appear of a competent distance from each other, and then according to the bigness of your *Dyal-plain*, to cut off the *Hour-lines*, *Stile*, and *Substile*, and so transfer them from the Floor to the *Plain* upon which the *Dyal* is to be made: but this way being too Mechanical for an Artift to exercise, I have in my

fore-

fore said *Art of Dyalling* shewed a more artificial way of performing this work *Geometrically*, by which although the *Dyal* should decline 80 or 88 degrees) upon a quarter of a sheet of paper you may draw your *Dyal*, and have the *Stile* of a competent height, and all the *Hour-lines* at a convenient distance one from another. And so let this suffice to be said in this place concerning *Upright declining Dyals*; for I intend not here to teach the *Art of Dyalling*, but shew the *Use* of the *Globes*.

PROB. VI.

Of direct South Reclining Dyals.

TO finde the distances of the *Hour-lines* upon these *Plains* by the *Globe*, this is the natural way.

The Operation by the Globe.

Having set the *Globe* to the *Latitude*, the *Index* of the *Hour-circle* to 12, the *Quadrant of Altitude* to the *Reclination*, with the end thereof in the *East* or *West* points of the *Horizon*, and brought the *Equinoctial Colure* to the *Meridian*, — Turn the *Globe* about, till the 1 hour, or 15 degrees of the *Equinoctial* hath passed the *Meridian*, and then see what degrees of the *Quadrant* of

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of *Altitude* are cut by the *Equinoctial Colure*; for those degrees counted from the upper part of the *Quadrant* downwards, are the degrees of the first hours distance (as of XI or I of the clock) from the *Meridian*, and so for all the rest of the Hour-distances.

This I say is the natural way; but the more artificial and better way, will be to refer such *Reclining Plains* to a *New Latitude* where they may become *Horizontal Plains*; and that may be easily effected, as I shall presently shew.

I formerly said, that a *South-Plain* may so recline, that the Reclination thereof may be either

Less than } the Complement of the known
 Equal to } *Latitude*.
 More than }

Now to refer any of these Plains to a new *Latitude* where they may become *Horizontal Plains*, observe,

1. If the Reclination of the Plain be less than the Complement of the known *Latitude*, Subtract the Plains Reclination from the Complement of the *Latitude*, and the Remainder shall be a *New Latitude*, where the *Reclining Plain* shall be an *Horizontal Plain*; and, in this Case, the *South-Pole* (in *North-Latitudes*) is always elevated.

2. If the Reclination be equal to the Complement of the known *Latitude*, then the *New Latitude*

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Latitude is no *Latitude* ; for the Plain lies in the very *Axis* of the World, and hath neither *Pole* elevated above it.

3. If the Reclination of the Plain be More (or Greater) than the Complement of the known *Latitude*, Subtract the Complement of the known *Latitude* from the Plains Reclination, and the Remainder shall be the *New Latitude* ; and in this Case, the *North-Pole* (in *North-Latitudes*) is always elevated.

Examples

Examples of these three Varieties.

1. of a South Plain; Reclining less than the Complement of the Latitude.

	d.	m.
Latitude	51	30
South reclin.	20	00
New Latitude	18	30
Hours	Hour-distances.	
	d.	m.
12	00	00
11 1	04	52
10 2	10	23
9 3	17	36
8 4	28	48
7 5	49	50
6	90	00

L Et a South-Plain in the Latitude of 51 deg. 30 min. North, recline 20 degrees: Now because 20 degrees is less than 38 deg. 30 min. the Complement of the known Latitude, subtract 20 degrees from 38 deg. 30 min. and there will remain 18 deg. 30 min. which will be the New Latitude. Wherefore you Rectify the Globe to 18 deg. 30 min. of Latitude, and

make an Horizontal Dial as is before taught in all respects, that Dial shall serve for a South Dial reclining 20 degrees in the Latitude of 51 deg. 30 min. the Hour-distances being such as are expressed in this Table, and the height of the Stile above the 12 a clock-line (or Substile) to be equal to the New Latitude, namely, 18 deg. 30 min.

II. of a South Plain Reclining equal to the Complement of the Latitude.

Thus if a *South Plain* in the *Latitude* of 51 deg. 30 min. shall recline 38 deg. 30 min. equal to the Complement of the *Latitude*, the *New Latitude* (as is said before) shall be no *Latitude*, and so neither *Pole* have any *Elevation*; wherefore the *Dial* is to be made in all respects as an *East or West-Dial* is made, only that *Hour-line* which in the *East or West-Dial* is the six a clock hour-line, must in these *Dials* be the *Hour-line* of 12, &c.

III. of a South Plain Reclining more than the Complement of the Latitude.

Suppose a *South Plain* in the *Latitude* of 51 deg. 30 min. should recline from the *Zenith* 60 degrees; forasmuch as 60 degrees is more than 38 deg. 30 min. the Complement of the known *Latitude*, subtract 38 deg. 30 min. from 60 degrees, and the remainder 21 deg. 30 min. will be the *New Latitude*.

Wherefore,

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	d.	m.
Latitude	51	30
South reclin.	60	00
New Latitude	21	30
Hours	Hour-distances.	
	d.	m.
12	00	00
11 1	05	37
10 2	11	57
9 3	20	08
8 4	32	25
7 5	53	50
6	90	00

Wherefore, if you make an *Horizontal Dial* for the *Latitude* of 21 deg. 30 min. you shall finde the *Hour-distances* to be such as are expressed in this Table, and shall serve for a *South-Dial* Reclining from the *Zenith* 60 degrees in the *Latitude* of 51 deg. 30 min. And the *Stile* of this *Dial* must be elevated above the *substile* (or *Hour-line* of 12) 21 deg.

30 min. equal to the *New Latitude*, and must point upwards towards the *North-Pole*, as must the *Stiles* of all *South-Plains* which recline more than the *Complement* of the *Latitude*.

PROB. VII.

Of North Reclining Dyals.

THE Natural way of finding of the *Hour-distances* for *North Reclining Dyals* is thus.

The Operation by the Globe.

Rectifie the *Globe* to the *Latitude*, set the *Quadrant of Altitude* to the *Reclination*, and the end of it to the *East* or *West* points of the *Horizon*, the *Index* of the *Hour-circle* to 12, and the *Equinoctial*

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notial Colure to the *Meridian* — Then turn the *Globe* about till 15 degrees of the *Equinoctial* have passed the *Meridian*, and then see what degrees of the *Quadrant of Altitude* are cut by the *Equinoctial Colure*; for those degrees (counted from the upper end of the *Quadrant of Altitude*) are the first hours distance from 12, as of 11 and 1 of the clock: and so of all the rest of the hours.

This is the natural way; but the better way will be to refer these *North Reclining Plains* to a *New Latitude*, as before you did the *South-Recliners*.

Of these *North Reclining Plains*, there are *Three Varieties*, as there were of the *South-Recliners*: for the *Reclination* may be either

Less than }
 Equal to } the *Latitude* of the Place.
 More than }

And to refer these to a *New Latitude* where they will be *Horizontal Plains*, you must observe,

1. If the *Reclination* of the Plain be less than the *Latitude*, add the Complement of the *Latitude* to the Plains *Reclination*, and the sum shall be the *New Latitude*, and the *North-Pole* (in *North-Latitudes*) shall be always elevated.

2. If the *Reclination* be equal to the *Latitude*, add the Complement of the *Latitude* and the *Reclination* together, and the sum shall be the *New Latitude*, which in this Case will always be 90 degrees.

3. If the *Reclination* be more than the *Latitude*,

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tude, add the Complement of the Reclination of the Plain, and the *Latitude* together, the sum of them shall be the *New Latitude*, and the *North-Pole* shall always be elevated.

Examples of these three Varieties.

I. *Of a North-Plain Reclining less than the Latitude.*

L Et a *North-Plain* in the *Latitude* of 51 deg. 30 min. recline from the *Zenith* 20 degrees; add 20 degrees (the Reclination) to 51 deg. 30 min. (the *Latitude*) the sum will be 71 deg. 30 min. which is the *New Latitude*.

	d.	m.
Latitude	51	30
North reclin.	20	00
New Latitude	71	30

Hours	Hour-distances.
	d. m.
12	00 00
11 1	14 17
10 2	28 42
9 3	43 29
8 4	58 40
7 5	74 13
6	90 00

Wherefore, if you rectifie the *Globe* to 71 deg. 30 min. of *Latitude*, and make an *Horizontal Dial* as is before taught, you shall finde the Hour-distances to be such as are expressed in this Table. And the *Stile* must be elevated above the *Substile* (or Hour-line of 12) equal to the *New Latitude*; and so shall this *Horizontal Dial*, made for the *Latitude* of 71 deg. 30 min. serve for a *North-Dial* Reclining 20 degrees in the *Latitude* of 51 deg. 30 min.

min.

II. of a North-Plain Reclining equal to the Latitude.

Let a North-Plain in the Latitude of London 51 deg. 30 min. recline from the Zenith 51 deg. 30 min. this added to the Complement of the Latitude, viz. 38 deg. 30 min. the sum will be 90: so that 90 degrees is the New Latitude. Wherefore, rectifie the Globe to 90 degrees of Latitude, so shall the Pole be in the Zenith, and the Equinoctial in the Horizon: then turn the Globe about till 15 degrees of the Equinoctial Colure have passed the Meridian, and it will rest at 15 degrees of the Horizon, which is the first Hours distance from 12. for in these Plains the degrees of the Equinoctial and the degrees of the Horizon being the same, there is no more in the making of this Dial, than to divide a Circle into 24 equal parts, and (being the New Latitude is 90 degrees) erect a Wyre perpendicularly in the Centre, and the Dial is finished.

III. of a North-Plain Reclining more than the Latitude.

Suppose that in the Latitude of 51 deg. 30 min. a North-Plain should recline from the Zenith 60 degrees; add 51 deg. 30 min. (the Latitude) to 30 degrees (the Complement of the Reclination) the sum will be 81 deg. 30 min. for the New Latitude. —

L 2

Where:

		d.	m.
Latitude		51	30
North reclin.		60	00
New Latitude		81	30

Hours		Hour-distances.	
		d.	m.
12		00	00
11	1	14	51
10	2	29	44
9	3	44	41
8	4	59	43
7	5	74	51
6		90	00

Wherefore, rectifie the *Globe* to the *Latitude* of 81 deg. 30 min. and (according to former directions) make an *Horizontal Dial* for that *Latitude*, and you shall finde the Hour-distances to be such as are expressed in this Table; and such an *Horizontal Dial* for the *Latitude* of 81 deg. 30 min. shall serve for a *North-Dial* reclining 60 deg. in the *Latitude* of 51 deg.

30 min. The *Stile* must be elevated above the 12 a clock hour-line equal to the *New Latitude*, namely, 81 deg. 30 min.

PROB. VIII.

Of East or West direct Recliners.

Such Plains as lie in the *Meridian* or *Azimuth* of *North* and *South*, and do recline from the *Zenith* towards the *East* or *West*-points of the *Horizon*, are called *East* or *West-Recliners*; and the Natural way of finding of the Hour-distances upon these Plains by the *Globes*, is thus.

I. The Operation by the Globe.

The *Globe* rectified to the *Latitude* of the place, the *Quadrant* of *Altitude* in the *Zenith*, the E-
qui-

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Equinoctial Colure brought to the *Meridian*, the *Index* of the Hour-wheel to 12, and the *Semicircle of Position* fixed to the *Meridian* in the North and South-points of the *Horizon*, elevate the *Semicircle of Position* to the Complement of the *Plains Reclination*, counted upon the *Quadrant of Altitude* from the *Horizon*; then move the *Globe* about, till the *Equinoctial Colure* hath passed 15 degrees of the *Equinoctial*, and then the degrees of the *Semicircle of Position*, cut by the *Equinoctial Colure* (counted from the *Meridian*) shall be the degrees that the first Hour-line of 11 or 1 shall be distant from the *Meridian*, or Hour-line of 12. — Also turn the *Globe* about till the *Equinoctial Colure* hath passed 30 degrees of the *Equinoctial Circle*, and the degrees cut by the *Colure* upon the *Semicircle of Position* shall be the degrees that the second Hour-line shall be distant from 12, &c.

This is the natural way of making of these *Dyals* by the *Globe*; but (to retain our former method) we will refer these *East* or *West* reclining *Dyals* to a *New Latitude*, where they shall be upright declining *Plains*; which to perform, is easie: For,

In all *East* or *West-Recliners*, the *New Latitude* is always the Complement of the known *Latitude*, and the *New Declination* is always the Complement of the *Reclination*; so that an *East* or *West-Plain* in the *Latitude* of 51 deg. 30 min. reclining 40 degrees will be an upright North-*Plain* declining *East* or *West* 50 degrees in the *Latitude* of 38 deg. 30 min. for 38 deg. 30 min. is the *New Latitude*, it being the Complement of

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the known *Latitude*, and 50 degrees is the *New Declination*, it being the Complement of the *Plains Reclination* in the known *Latitude*; wherefore, if (according to the directions given you in the *Fifth Problem*) you make an upright *Dyal*, declining 50 degrees for the *Latitude* of 38 deg. 30 min. you shall finde all the *Hour-distances* to be such as are expressed in this Table,

		d.	m.
East Reclining		40.00	
Latitude		51.30	
New Latitude		38.30	
Declination		50.00	
Distance of			
Substile from	}	43.55	
Meridian			
Stiles height		30.12	
Hours from Noon.	Hour-di- stances on the Plain.		
		d.	m.
12		00	00
1 11		15	14
2 10		26	12
3 9		34	57
4 8		42	42
5 7		50	21
6 6		58	39
7 5		68	43
8 4		82	15
9 3		22	09
10 2		48	43
11 1		75	52

The distance of the *Substile* from the *Meridian* to be 43 deg. 55 min. and the height of the *Pole* or *Stile* above the *Plain* or *Substile*, to be 30 deg. 12 min. which declining *Dyal* in this *New Latitude*, shall be an *East* or *West* reclining *Dyal* in the known *Latitude*.

But in the placing of the *Dyal* upon the *Reclining Plain*, there is this difference: For whereas in all Upright declining *Plains*, the *Meridian* or *Hour-line* of 12 is perpendicular to the *Horizon*, in all *East* or *West-Recliners* the *Meridian* (or *Hour-line* of 12) must lie parallel to the *Horizon*. And here note also, that all *East-Recliners* in the known *Latitude*, are *North-East-decliners* in the

the *New Latitude*, and all *West-Recliners* are *North-West-decliners*. All which may be seen in

FIG. V.

And note farther, that upon all *East* and *West-Recliners* (how far soever) in *North-Latitudes*, the *North-Pole* is always elevated ; and upon the *East* and *West-Incliners* opposite to them, the *South Pole*.

Thus have you the manner of making of all sorts of direct Reclining or Inclining *Dyals* by the *Globes* two several ways ; namely, by the Natural way, as they lie in respect of the *Horizon*, where they are to be placed Obliquely : And also a more artificial way, by referring them to *New Latitudes* and *New Declinations*, where they may become *Horizontal* or *Upright declining Plains*. And now let us proceed to

P R O B. I X.

Of Declining, Reclining, or Inclining Plains.

Such Plains as do not directly behold the *East*, *West*, *North*, or *South*-points of the *Horizon*, nor do stand perpendicular thereunto, but fall back from the *Zenith*, these Plains are called *North* or *South-Recliners*. For the making of these kinds of *Dyals* by the *Globes*, the natural way followeth.

I. The Operation by the Globe.

For our *Example*, Let us suppose a Plain in the Latitude of 51 deg. 30 min. to decline from the North-part of the Meridian towards the West 72 degrees, and also to Recline from the Zenith 26 deg. 34 min.

1. Elevate your *Globe* to the Latitude of the place 51 deg. 30 min. the *Quadrant of Altitude* in the Zenith, the *Hour-circle* to 12, and the *Equinoctial Colure* to the Meridian.

2. The Declination being 72 degrees Westward, count upon the *Horizon* 20 degrees (the Complement thereof, from the South-part of the Meridian Westward, and from the North-part of the Meridian Eastward; and to these two Points in the *Horizon*, bring the two extreme ends of your *Circle of Position*, (or which is far better, a narrow Plate of thin Brass, containing a compleat Semicircle at least, divided into degrees as the *Quadrant of Altitude* is, beginning the divisions at the middle, and numbering them both ways towards the ends) and there fix it. Then bring the *Quadrant of Altitude* to 20 degrees in the *Horizon*, counted from the East Southward. — Now (because the Plain Reclines 26 deg. 34 min.) count those degrees upon the *Quadrant* downwards, from the Pole, and to that Point bring down the thin Plate of Brass, representing your Plain, and there fix it; for now is your *Globe* prepared for the making of your *Dial*. And,

1. For the Hour-distances :

If you turn the *Globe* about *Eastward*, till 15 degrees of the *Equinoctial* have passed the *Meridian*, you shall finde upon the Plain intercepted between the *Colure* and the *Meridian* 26 deg. 3 min. which is the first Hours distance from 12 upon your Plain. Again, turn the *Globe* about still *Eastward*, and you shall finde 44 deg. 30 min. intercepted, which is the second Hours distance upon the Plain.

Also, if you turn about the *Globe Westward* till 15 degrees of the *Equinoctial* have passed the *Meridian*, there will be cut by the *Colure* upon the Plain 28 deg. 4 min. which is the first Hours distance on the other side of the *Meridian*. And so do with all the rest, and you shall finde them as in this following Table.

Hours	Minutes	Seconds	Hours	Minutes	Seconds
1	26	3	1	26	3
2	44	30	2	44	30
3	1	15	3	1	15
4	18	45	4	18	45
5	26	15	5	26	15
6	34	45	6	34	45
7	42	15	7	42	15
8	50	45	8	50	45
9	58	15	9	58	15
10	6	45	10	6	45
11	14	15	11	14	15

Now

	<i>d. m.</i>
North declining	72.00
Reclining	26.34
Distance between the Merid. & Hor.	36.00
Distance between the Plain & Zen.	58.17
Height o'th' Pole above the Plain.	31.28
Distance of the Subst. & Merid.	82.04

	<i>d.</i>	<i>m.</i>
12	00	00
11	26	03
10	44	30
9	57	47
8	67	53
7	76	12
Substile.	Substile.	
6	84	15
5	87	38
4	78	25
3	66	48
2	50	46
1	28	04

Now (besides these Flour-distances) there must be Four other things found before we come to the Geometrical Construction of this Dyal; and those are

1. *The Arch of the Plain (or the distance) between the Meridian and Horizon;* and that may be found thus.---

Take with your Compasses (or with a thin Plate of Brass or Horn divided) the distance upon the Plain, from the Intersection of the Plain with the Horizon, to the Intersection of the Plain with the Meridian; and those degrees, namely 36, are the distance required.

2. *The Arch of the Meridian between the Plain and the Zenith.* The which may be thus found. For the degrees of the Meridian intercepted between the Plain and the Zenith, viz. 58 deg. 17 min. is this Arch.

3. *The height of the Pole or Stile above the Plain.* — And to finde this, You must continue your

your *Quadrant of Altitude* from the *Zenith* below the *Horizon*, so much as is the *Reclination* of the *Plain* 26 deg. 34 min. And mark that Point, for it is the *Pole* of the *Reclining Plain*. Then a thin Plate of Brass, (for the *Quadrant of Altitude* will be (for the most part) too short) divided, being extended from the *North-Pole* towards the *South-Pole*) and passing through the *Pole* of the *Plain*, (which is the Point before found) mark where the Plate cutteth the *Plain*; and the number of degrees of the Plate that are contained between the *Pole* and the *Plain*, which will be here found 31 deg. 28 min. is the height of the *Pole* or *Stile* above the *Plain* or *Substile*.

4. *The distance of the Substile from the Meridian.* — And that is, the number of degrees of the Plate representing the *Plain*, which are contained between the Plate which came from the *Pole* of the *World* to the *Pole* of the *Plain*, and the *Intersection* of the *Plain* with the *Meridian*, which in this *Example* will be found to be 82 deg. 4 min.

II. The Geometrical Construction of this Dyal.

FIG. VI.

1. Upon the *Plain* upon which you intend to describe your *Dyal*, draw an *Horizontal-line* thereupon, as *AB*; and another perpendicular thereunto *DG*, for the *Vertical line* of your *Plain*, cutting the former *AB* in the point *G*, which point *C* make the *Centre* of your *Dyal*.

2. Upon the *Centre C*, with 60 degrees of a
Line

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Line of Chords describe a Circle, as A F B G. then take 36 degrees (the distance of the Meridian from the Horizon,) and set it from A to 12 downwards, and from B to 12 upwards, and draw the Line 12 C 12 for the Hour-line of XII.

3. Take 82 deg. 4 min. (the distance of the Substile from the Meridian) and set them from 12 upwards to G on the left hand, and downwards from 12 to G on the right hand, drawing the Line G C G through the Centre, for the Substilar-line of both the Dyals: — And the height of the Pole or Stile above the Plain being 31 deg. 28 min. set those degrees from G to H, both above and below, and draw the Line H C H quite through the Centre, for the Axis or Stiles of both Dyals.

4. Laying your Table of Hour-distances before you, and there finding the first Hours distance from 12 is 26 deg. 3 min. set that distance upon the Circle from 12 upwards to 1, and from 12 (on the other side) downwards to 11, and draw the Lines C 1, and C 11, for the Hour-lines of 11 and 1 a clock, which will both be but one straight line.

Do thus with all the hours in the Table till you come to the Substile, and then, (beginning at the bottom of the Table)

5. Take 48 deg. 4 min. and set them from 12 on the Right hand downwards to 11, and from 12 on the Left hand upwards to 1, and draw the Line C 11 in the North Reclining Plain, for the Sun will never shine upon the South Incl-

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clining Plain at 1, otherwise you should have drawn it through the Centre as you did before. Do the like with all the rest of the hours, drawing such through the Centre as you finde occasion for; which the sight of the Figure will inform you how to do, better than many Words.

Lastly, Erect your *Stile* perpendicular to your *Substile*, making an *Angle* therewith equal to the elevation thereof; namely, 31 deg. 28 min. and your *Dyals* are finished. — And in the making of these, you have made two others also, viz. A *North Declining* 72 degrees *Eastward*, and *Inclining* 26 deg. 34 min. and a *South Declining Westward* 72 degrees, and *Inclining* as the other; all which is done (and may easily be apprehended by any person) as is discovered in the 4th Problem of this Book for *Upright declining Plains*.

Thus have you the manner of making all manner of plain *Sun-Dyals* by the *Globes*, not only by the *Natural* way, as they are *Naturally* represented upon the *Globe*; but by an *Artificial* way also, by referring them to *New Latitudes*, in which they shall become *Horizontal Dyals*, or at least *Upright Decliners*. It resteth now that I should say something concerning the inserting of *Tropicks*, *Parallels*, *Italian*, *Babylonish*, and *Jewish Hours*, as also *Almicanter*s, *Azimuth*s, and such other *Spherical Lines* and *Arches* as are oftentimes inserted upon *Dyal-Plains* for the delight and curiosity of the Ingenious: but these, with some other things concerning the *Gnomonicks*, I shall refer to another Treatise by it self.

ASTRO-

ASTROLOGICAL Problems.

INTRODUCTION.

Astrologie consisteth principally of two parts, viz. the one *Mathematical*, as is the *Astronomical part*; the other *Judiciary*, as is the *Astrological part*.

The *Mathematical part* teacheth how in a *Scheme* or *Figure* (as they call it) to represent the *Face* of the Heavens in *Plano*, for any hour of the day or night, at all times of the year, and in all parts of the world.

The *Astrological part* teacheth how (from the sight of the said position of the *Scheme* or *Figure* of the Heavens at the time of its erection) to give a determinate *Judgement* of what was demanded upon that *Erection* of the *Scheme* or *Figure*: as of *Annual Revolutions*, *Elections*, the *Nativity* of a Person.

The principal Authors that have given their Opinions concerning the dividing of the Heavens into 12 *Mansions* or *Houses*, are, 1 *Ptolomy*, 2 *Alcabirius*, 3 *Campanus*, and 4 *Regiomontanus*: Which last way, is now generally received and practised among the *Astrologers* of these times, and by them termed the *Rational way of Regiomontanus*.
Now,

Now, because (as I said before) that the Erection of a Figure of the Heavens is the Mathematical or Astronomical part of Astrologie, I shall therefore shew how by the Globes to Erect a Figure of the Heavens according to the various ways of the Four forementioned Authors, and that for the same Latitude and Time.

P R O B. I.

How to Erect a Figure of the Heavens in the Latitude of London 51 deg. 20 min. N. for the 10th day of March, at 49 min. after 9 in the Forenoon; at which time the Sun enters into the first scruple of Aries this Year 1675.

- I. *According to the (esteemed) Rational way of Regiomontanus.*

Defini-
tion 1.] **T**HE Heavens are divided into XII Houses or Mansions, by 12 Semicircle of Position; for which purpose, to some Globes, there is made one of Brass, which is fixed in the Intersections of the Meridian and Horizon, by the Elevation or Depression whereof the Heavens may be divided into parts or houses through each degree of the Ecliptick.

Defi-

Definition 2.] Of these XII Houses or Mansions of Heaven, Four are called *Cardinal*, as (1.) the *Horoscope*, or *Ascendent*, or *Cuspis* of the *First House*. (2.) The *Medium Cæli*, or Angle of the *South*, or *Cuspis* of the *Tenth House*. (3.) The *Descendent*, or Angle of the *West*, or the *Cuspis* of the *Seventh House*. (4.) The *Imum Cæli*, or the Angle of the *North*, or the *Cuspis* of the *Fourth house*.

Definition 3.] *Regiomontanus* divides the Heavens into XII Houses according to his way, by the *Circle of Position* passing through every 30th degree of the *Equinoctial*, and cutting the *Ecliptick* at several points, which are the *Cuspises* of the several Houses: — So that when the *Globe* is set to the *Latitude*, and the *Hour-wheel* Rectified and brought to the *Given hour*, you have the *Cuspises* of the Four *Cardinal houses* given: For,

The degree { East-side of the *Horizon*,
of the E. { South-part of the *Meridian*,
ecliptick cut { West-side of the *Horizon*,
by the { North-part of the *Meridian*,

Gives the *Cuspis* of the { First
Tenth
Seventh } House.
Fourth }

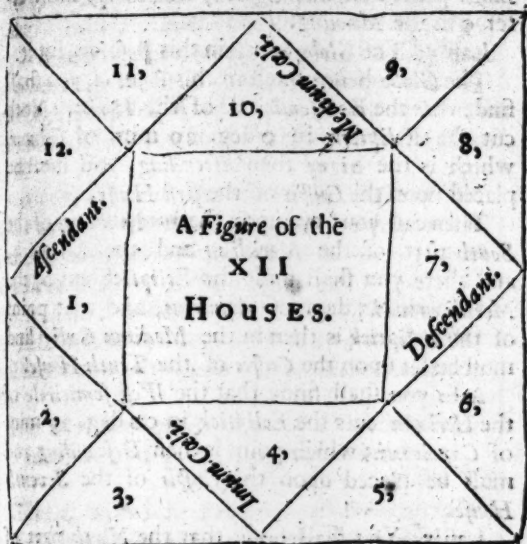
The *Cuspises* of the other 8 Houses are found by the motion of the *Circle of Position*, as shall be shewed by and by.

Definition 4.] The Houses are denominated by 1, 2, 3, 4, &c. to 12, from the *Ascendent* downwards to the *Imum Cæli*, up again to the *Descendant*,

Astrological Problems.

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dant, and again by *Medium Cali* down to the *Ascendant*. As in the following *Scheme*.



Let this suffice for *Definition*, and now we will come to the *Practise* by the *Globes*:

Practise. **F**irst, to the day proposed, the 10th of March, finde (by the first *Astronomical Problem*) the Sun's place in the *Ecliptick* at noon, which you shall finde to be in 0 deg. 5 min. of *Aries*.

Secondly, Set the *Globe* to the *Latitude* 51 deg. 30 min.

Thirdly, Bring the *Sun's* place at Noon (0 deg. 5 min.)

5 min. of *Aries*) to the *Meridian*.

Fourthly, Turn the *Globe* about till the *Hour-Index* point to the *hour* given, viz. to 49 min. after 9 in the *Morning*.

Lastly, The *Globe* being in this *Position*, fix it.

The *Globe* being fixed in this *Position*, you shall finde that the *East-semicircle* of the *Horizon* doth cut the *Ecliptick* in 0 deg. 29 min. of *Cancer*, which is the *signe* then *Ascending*, and must be placed upon the *Cuspis* of the first *House*.

Then cast your eye upon the *Intersection* of the *South-part* of the *Meridian* and the *Ecliptick*, and there you shall finde the *Ecliptick* cut by the *Meridian* in 25 deg. of *Aquarius*, and that point of the *Ecliptick* is then in the *Medium Cæli*, and must be set upon the *Cuspis* of the *Tenth House*.

Also you shall finde that the *West-semicircle* of the *Horizon* cuts the *Ecliptick* in 00 deg. 29 min. of *Capricorn*; which point is then *Descending*, and must be placed upon the *Cuspis* of the *Seventh House*.

Lastly, You shall finde that the *North-part* of the *Meridian* doth cut the *Ecliptick* in the 25th deg. of *Leo*, which point is then upon the *Imum Cæli*, and must be placed upon the *Cuspis* of the *Fourth House*.

Thus have you found the *Points* of the *Ecliptick* which do occupie the *Cuspises* of the *Four Cardinal Houses*: Now for the other *Eight Houses*.

Let the *Globe* still rest in its former *Position*, and then,

First,

First, Bring the *Circle of Position* to its place on the *East-side* of the *Horizon*; and being there fixed, raise it upwards towards the *Meridian*, till 30 deg. of the *Equinoctial* be intercepted between the *Horizon* and the *Circle of Position*; and then you shall finde that the *Circle of Position* will intersect the *Ecliptick* in 20 deg. of *Taurus*; which degrees must be set upon the *Cuspis* of the *Twelfth House*.

Secondly, Move the *Circle of Position* yet higher towards the *Meridian*, till 30 deg. more of the *Equinoctial* be intercepted between it and the *Horizon*, (in all 60 deg.) and when it so hath, you shall finde the *Circle of Position* will cut the *Ecliptick* in 30 deg. of *Pisces*; which point must be set upon the *Cuspis* of the *Eleventh House*.

The *Meridian* gives the *Cuspis* of the *Tenth House* in 25 deg. of *Aquarius*, as before.

Thirdly, Move the *Semicircle of Position* from the *East-side* of the *Horizon* to the *West-side*, and move it downwards from the *Meridian*, till 30 deg. of the *Equinoctial* be intercepted between the *Meridian* and *Circle of Position*, and then you shall finde that the *Circle of Position* will intersect the *Ecliptick* in 7 deg. of *Aquarius*; which point must be set upon the *Cuspis* of the *Ninth House*.

Fourthly, Move the *Circle of Position* yet lower 30 deg. i. e. 60 deg. from the *Meridian* downwards, and then you shall finde the *Position-Circle* to cut the *Ecliptick* in 21 deg. of *Capricorn*; which point must be set upon the *Cuspis* of the *Eighth House*.

The *Descendant* or *Cuspis* of the *Seventh House* is the Intersection of the *West-side* of the *Horizon* and *Ecliptick*, which is in 00 deg. 29 min. of *Capricorn*, as before.

And thus have you found the *Cuspises* of the *Four Houses* above the *Horizon*, beside the *Ascendant* and the *Medium Celi*; viz. of the 12, 11, 9 and 8 houses. Now the *Cuspises* of the *Four* other Houses under the *Earth* have the same degrees of the opposite Signs upon them: For,

20 deg. of <i>Taurus</i>	} being upon the	Cuspis of the	} 12 11 9 8	} house
26 deg. of <i>Pisces</i>				
7 deg. of <i>Aquarium</i>				
21 deg. of <i>Capricorn</i>				

20 deg. of <i>Scorpio</i>	} will be on	the Cusp	of the	} 6 5 3 2	} house.
26 deg. of <i>Virgo</i>					
7 deg. of <i>Leo</i>					
21 deg. of <i>Leo</i>					

For the Six Signs

Aries, Taurus, Gemini, Cancer, Leo, Virgo,

are opposite to

Libra, Scorpio, Sagitt. Capric. Aquar. Pisces.

And this is the manner how (by the *Globe*) to erect a *Figure* according to the (reputed) *Rational way* of *Regiomontanus*.

Now if you would insert the places of the *Planets* into your *Figure*, (for it is them that

the *Astrologer* principally giveth Judgement by) your best way will be to have recourse to some good *Ephemeris* (if you cannot Calculate them from *Astronomical Tables*) and so may you finde the places of the several *Planets* at the time for which this *Figure* was Erected (viz. *March 10. 1675. 49 min. after 9 in the forenoon*) to be as followeth. *Viz.*

	deg.
♄ Saturn	28 Aries.
♃ Jupiter	19 Sagitarium.
♂ Mars	17 Gemini.
☉ Sol	00 Aries.
♀ Venus	18 Aquarium.
☿ Mercury	15 Aries.
☾ Luna	24 Capricorn.
☊ Dragons Tail	17 Capricorn.
♁ Dragons Head	17 Cancer.

Having thus obtained the places of the *Planets* either by *Calculation*, by *Ephemerides*, or *Instrument*, you may place them in their Correspondent places in your *Figure*, as is here done, and so is your *Figure* ready to give your Judgement upon.

M 3

Lat.



II. To Erect a Figure of the Heavens
 for the forementioned time, Anno
 1675, March 10 day at 49 min.
 past 9 in the Morning.

According to Campanus.

Defini-
 tion.] **T**He Cuspises of the Four Cardinal
 Houses according to Campanus, viz.
 the Ascendent, Mid-heaven, Descendent, and Imum
 Caeli, are the same as they were according to Re-
 gio

Regiomontanus: But, as *Regiomontanus* divided the Houses by the Circle of Positions passing through each 30th degree of the Equinoctial, and intersecting the Ecliptick in the Cuspises of the several Houses; *Campanus* divides the 12 Houses of Heaven by the Position-Circles passing through each 30th degree of the prime Vertical Circle, (or Azimuth of East and West) and so intersecting the Ecliptick in the Cuspises of the several Houses. So that to Erect a Figure according to *Campanus* way, you must do as followeth. *Viz.*

Practice.] You must first set the Globe to the Latitude, bring the Sun's place at noon for the day given to the Meridian, and the Hour-index to 12, and the Circle of Position to the East side of the Horizon, then turn the Globe about till the Index point at the given hour, and then fix the Globe. Thus far as in the former way of *Regiomontanus*; and the Cuspises of the First, Fourth, Seventh, and Tenth Houses will be the same as in his way. But now to proceed according to *Campanus*.

The Globe seated and fixed in this Position, bring the Quadrant of Altitude to the Zenith, and there fix it; and bring the lower part of the Quadrant of Altitude to the East-point of the Horizon, and there keeping of it fixed:

1. Elevate the Circle of Position, till it cut 30 deg. of the Quadrant of Altitude, and then see what degrees of the Ecliptick are cut by the Position Circle, which you shall finde to be 22 deg. of Aries; which point must be set upon the Cuspis of the Twelfth House.

2. Move the Circle of Position yet 30 deg. higher upon the Quadrant of Altitude, namely,

to 60 deg. from the *Horizon*, and then see what degree of the *Ecliptick* is cut thereby, and you shall finde that the *Position-circle* cuts the *Ecliptick* in 12 deg. of *Pisces*, which must be set upon the *Cuspis* of the *Eleventh House*.

The *Meridian* cuts the *Ecliptick* in 25 deg. of *Aquarius*, which is the *Cuspis* of the *Tenth House*, or *Mid-heaven*, as before.

3. Remove the *Circle of Position*, and also the *Quadrant of Altitude*, from the *East* to the *West-side* of the *Horizon*, and there move him from the *Meridian downwards*, till 30 deg. of the *Quadrant of Altitude* be intercepted between the *Zenith* and the *Circle of Position*, and then see where the *Position-circle* cuts the *Ecliptick*, which will be in 12 deg. of *Aquarius*; and those degrees must be set upon the *Cuspis* of the *Ninth House*.

4. Let down the *Circle of Position* 30 deg. more upon the *Quadrant of Altitude*, that is, 60 deg. distant from the *Zenith*, and then look what degrees of the *Ecliptick* are cut by the *Position-circle*, which you will finde to be 28 deg. of *Capricorn*; which degrees must be set upon the *Cuspis* of the *Eighth House*.

The *Cuspis* of the *Seventh House* is 00 deg. 29 min. of *Capricorn*, being the *Intersection* of the *West-side* of the *Horizon* with the *Ecliptick*, as before.

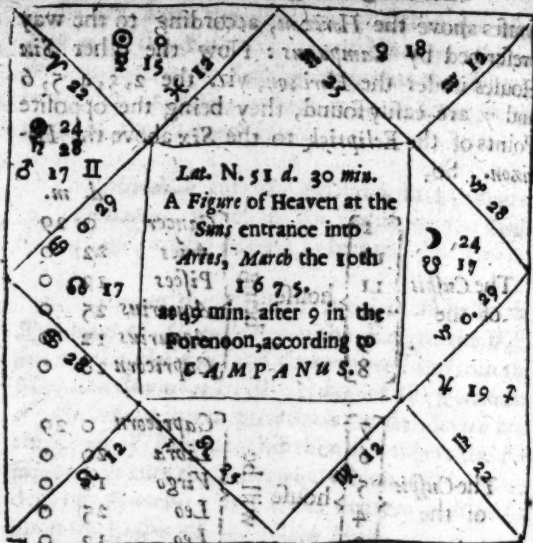
And by this Artifice you have obtained the degrees belonging to the 1, 12, 11, 10, 9, and 8 houses

houses above the *Horizon*, according to the way prescribed by *Campanus*: Now the other Six Houses under the *Horizon*, viz. the 2, 3, 4, 5, 6 and 7, are easily found, they being the opposite Points of the *Ecliptick* to the Six above the *Horizon*. So,

		d. m.	
The <i>Cuspis</i> of the	1	Cancer	0 29
	12	Aries	22 0
	11	Pisces	12 0
	10	Aquarius	25 0
	9	Aquarius	12 0
The <i>Cuspis</i> of the	8	Capricorn	28 0
	7	Capricorn	0 29
	6	Libra	20 0
	5	Virgo	12 0
	4	Leo	25 0
The <i>Cuspis</i> of the	3	Leo	12 0
	2	Cancer	28 0

And thus have you the *Cuspises* of the several Houses according to the way prescribed by *Campanus*; which *Figure* having the *Planets* placed therein, will stand as in the following *Scheme*.

Defin- *Latitude* would have the XII *Hours* of *Heaven* to be divided by *Dominion*, or *Circle* of *Position* drawn from the *Pole* of the *World* through every *zodiacal* sign, beginning at the point of the *Ecliptick* ascending, and so counting 30 deg. upon the



III. To Erect a Figure of Heaven
for the forementioned time, viz.
March 10. 1675, at 49 min. af-
ter 9 in the Forenoon.

According to Alcabitius.

Definition.] A *Leabitims* would have the XII *Houses* of Heaven to be divided by *Domifying Circles*, or *Circles of Position* drawn from the *Poles* of the *World* through every 30th deg. of the *Equator*, beginning at the point of the *Ecliptick Ascending*; and so counting 30 deg. upon the

the Equinoctial from thence, shall be the *Cusps* of the several Houses. — Wherefore, to Erect a Figure according to this mode, do as followeth.

Practice. You must Rectifie the Globe to the Latitude, bring the Suns place at noon to the Meridian, the Index of the Hour-wheel to 12 at noon, and turn the Globe about to the hour given, and then fix it; so shall the *Ascendent* be the same as in the two former ways, viz. 00 deg. 29 min. of Cancer.

Then look what Meridian passeth through the *Ascendent*, and count 30 deg. more upon the Equinoctial; and that Meridian where it passeth through the *Ecliptick* shall be the *Cuspis* of the Twelfth House; and 30 deg. forwarder that Meridian shall cut the *Ecliptick* in the *Cuspis* of the Eleventh House, and so onward till you come to the *Cuspis* of the Descendent. And thus,

If from that Meridian which passeth through 00 deg. 29 min. of the *Ecliptick*, you count 30 deg. more upon the Equinoctial, you shall finde that

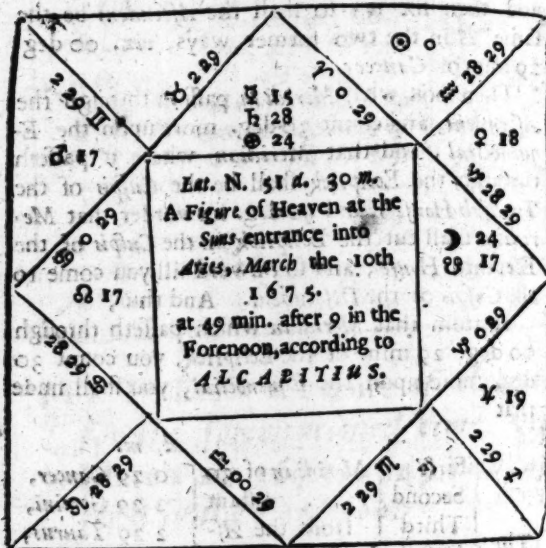
		d. m.
The	First Meridian of 30	0 29 Cancer,
	Second deg. distant	2 29 Gemini,
	Third from the As-	2 29 Taurus,
	Fourth cendent, will	0 29 Aries,
	Fifth cut the Eclip-	28 29 Aquarius,
	Sixth tick in	28 29 Capricorn,

Which are the
Cusps of the
 1
 12
 11
 10
 9
 8
 houses.

And

Astrological Problems.

And the opposite *Signes* and *degrees* of the *E-
cliptick* shall give the *Cusps* of the *Six* other
under the Earth; namely, of the 7, 6, 5, 4, 3,
and 2. And thus your *Figure* being erected, and
the *Planets* placed therein, you will finde it to be
as in the following *Scheme*.



IV. To Erect a Figure for the fore-mentioned time, viz. March 10. 1675. at 49 min. after 9 in the Forenoon, the Sun then entering Aries in the Meridian of London.

According to the way prescribed by Ptolomy.

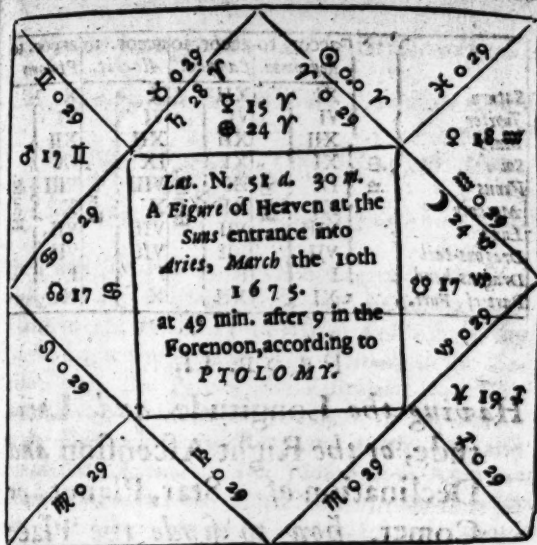
Defini- tion. Ptolomy adviseth that the Heavens should be divided into 12 Houses or Mansions, by Domifying Circles drawn through the Poles of the Ecliptick, and through every 30th deg. thereof from the Ascendant downwards, round about. — Wherefore to Erect a Figure of the Heavens according to this way of Ptolomy, do thus.

Practice. Rectifie the Globe and Hour-circle as before, and you shall have the same Ascendant, viz. 00 deg. 29 min. of Cancer to Ascend, which is the Cuspis of the First House; then 30 deg. forwarder, downwards, will be 00 deg. 29 min. of Leo, for the Cuspis of the Second House, &c.

			d. m.
	[1]		o 29 Cancer,
	[2]		o 29 Leo,
So the Cusp	[3]	house	o 29 Virgo,
pis of the	[4]		o 29 Libra,
	[5]		o 29 Scorpio,
	[6]		o 29 Sagittary.
And	[7]	will be	o 29 Capricorn.
	[8]		o 29 Aquarius.
the Cusp	[9]	house	o 29 Pisces.
of the	[10]		o 29 Aries.
	[11]		o 29 Taurus.
	[12]		o 29 Gemini.

And so a Figure Erected for the forementioned time, according to this prescription of Ptolomy, and the Planets placed therein, will appear as in the following Scheme or Figure.

And



And thus have I shewed you the manner of Erecting of a Figure of the Heavens according to the Prescriptions of the four forementioned Authors, and have placed the Planets, Dragons-head and Tail, and the place of Fortune in each of them; by which you may see, that according to these four Varieties of Erections, the Planets keep not in the same Houses, as by the following Synopsis appears. For,

	accor. to <i>Regiomen.</i>	accor. to <i>Campan.</i>	accor. to <i>Alcabit.</i>	accor. to <i>Ptolemy</i>
<i>Saturn</i>	XI	XII	X	X
<i>Jupiter</i>	VI	VI	VI	VI
<i>Mars</i>	XII	XII	XII	XII
<i>Sol</i>	XI	XI	IX	IX
<i>Venus</i>	IX	IX	VIII	VIII
<i>Mercury</i>	XI	XI	X	X
<i>Luna</i>	VIII	VII	VII	VII
<i>Dragons-tail</i>	VII	VII	VII	VII
<i>Dragons-head</i>	I	I	I	I
<i>Part of Fort.</i>	XI	XII	X	X

PROB. II.

Having the Longitude and Latitude, or the Right Ascension and Declination of a Star, Planet, or Comet, how to finde the Place thereof upon the Globe, and to insert it therein if need require.

WHat the Longitude, Latitude, Right Ascension and Declination of a Star or Planet is, you have heretofore defined; and in the last Problem you are taught how to Erect a Figure of the Heavens Four several ways. Now if you would see (upon the Globe it self) in what House any of the Planets are, without Erecting a Figure, you were best to make Marks, or set Characters of those Planets, Comets, or the like, upon the Globe, before you delineate your Figure upon Paper; which to effect, do thus.

I. By

I. *By the Longitude and Latitude given.*

If the *Latitude* of the *Star*, *Planet*, or *Comet*

be { *Northward* } Elevate { *North-pole* } of the
 { *Southward* } the { *South-pole* } *Globe* to
 66d.30m.

then will the *Pole* of the *Ecliptick* be in the *Zenith*, and the *Ecliptick* circle will lie in the very *Plain* of the *Horizon*; in which *Position* of the *Globe*, screw the *Quadrant of Altitude* in the *Zenith*, over the *Pole* of the *Ecliptick*. — This done, bring the point of *Longitude* of the *Planet* in the *Ecliptick* to the *Quadrant of Altitude*, and count the *Latitude* of the *Planet* upon the *Quadrant*, and under the degree of *Latitude* shall be the point upon the *Globe* in which the *Planet* or *Star* in the *Heavens* is.

And so the *Longitude* of the *Seven Planets* being as it is expressed in the following *Table*, such *Longitude* and *Latitude* they had at the time of the *Erection* of the former *Figure*, *March* 10. 1675, at 49 min. after 9 in the *Forenoon*. Now, if you finde their respective *Points* upon the *Globe* (as I have now shewed you how to do) you may then, not only see in what *House* each of them shall be, but also what *Fixed Stars* are there, and what *Fixed Stars* are in the other *Houses* also.

N

The

The Longitude of	♄ Saturn	27.49	♄	And the Latitude	2.17	M.A.
	♃ Jupiter	18.55	♃		0.38	S. D.
	♂ Mars	17.24	♂		1.48	S. A.
	☉ Sol	00.00	☉		0.00.	
	♀ Venus	17.56	♀		3.44	S. D.
	☿ Mercury	15.15	☿		1.07	S. A.
	☾ Luna	24.47	☾		0.35	S. D.

II. By the Right Ascension and Declination given.

Suppose a *Star, Planet, or Comet* to have 147 deg. 43 min. of *Right Ascension*, and 33 deg. 33 min. of *North Declination*, as the *Star Regulus*, or the *Lions Heart* hath, and you would finde its place upon the *Globe*;

Count 147 deg. 43 min. the *Stars Right Ascension* upon the *Equinoctial* from the beginning of *Aries*, and bring that point of the *Equinoctial* to the *General Meridian*; and keeping the *Globe* there, count 33 deg. 33 min. the *Stars Declination* upon the *Meridian* upwards, (because the *Stars Declination* is *Northward*) and that point shall be the place of *Regulus* upon the *Globe*. And thus may any part, or point, in the *Heavens* be found upon the *Globe*, if either the *Longitude* and *Latitude*, or the *Right Ascension* and *Declination* of that point be first known.

PROB.

P R O B. III.

To know in what House, or under what Circle of Position, any Star, Planet, or point of the Ecliptick is.

Rectifie the *Globe* to the *Latitude*, the *Quadrant of Altitude* to the *Zenith*, the place of the *Sun* in the *Ecliptick* to the *Meridian*, and the *Hour-circle* to 12; then turn the *Globe* about to the hour given, and bring the *Quadrant of Altitude* to the *East* or *West* points of the *Horizon*, and there fix the *Globe*: Then move the *Circle of Position* upwards, till it touch the *Star*, *Planet*, or other Points of the *Ecliptick*, which you desire to know the *Circle of Position* of, then shall the *Position-circle* cross the *Quadrant of Altitude* in the number of that *Circle of Position* in which that *Star*, *Planet*, or other Point of the *Ecliptick* is.

Thus, If at the time of the *Erection* of the former *Figure* it were required to know in what *Circle of Position* (or house) the *Pleiades* or *Seven Stars* was; Rectifie the *Globe* as before, and bring the *Position-circle* to the *Pleiades*; then shall the *Circle of Position* cut the *Quadrant of Altitude* in 42 deg. and under that *Circle of Position* is the *Pleiades* or *Seven Stars* at that time, and so consequently in the XIIth House.

I might here shew how to finde the place of the Thing which *Astrologers* call the *Part of For-*

tune. Also how (as they call it) to Direct a *Figure*, and to finde out *Revolutions*, &c. But forasmuch as these things are not so *Mathematical* as to require a *Globe*, or other *Mathematical Instruments*, either to *Demonstrate* them by, or to ease the *Operation*; I shall refer them that have occasion for such *things*, to the *Arithmetical working* of them by the Pen, as most convenient, and reserve the *Globes* for other purposes.

P R O B. I V.

Of the Planetary hours, how to finde the Length thereof, and what Planet it is that Reigneth any common hour of the day or night.

Definition 1. A Planetary hour for the day, is the 12th part of the *Artificial day* counted from the time of the *Suns Rising* to its *Setting*; and a Planetary hour for the night, is the 12th part of the *Artificial night* counted from the time of the *Sun Setting* to the time of its next *Rising*: So that the *Planetary hours* are not of the same length all the year long, as the *Common hours* of 60 min. are, but are some times of the year longer, and sometimes shorter. — For, when the *Artificial day* is above 12 hours long, (as it is all the time that the *Sun* is in the *Six Northern Signes*) then doth a *Planetary hour*
con-

contain more than 60 min. — And when the *Artificial day* is less than 12 hours long, (as it is all the time that the *Sun* is in the *Six Southern Signs*) then doth the *Planetary hour* contain less than 60 min. — But when the *Sun* is in the *Equinoctial*, and the *Artificial day* and *night* are equal (each containing just 12 hours) then the *Common hour* and the *Planetary hour* are the same, either of them containing just 60 min.

Definit. 2.] The *Planetary hours* take their denominations from the *Planetary names* of the *days* of the *week*, as

Sunday	}	hath for its	} <i>Planetary</i>	Sol.
Monday				Luna.
Tuesday	>	name	<	Mars.
Wednesday				Mercury.
Thursday	}			Jupiter.
Friday				Venus.
Saturday	}			Saturn.

So that upon whatsoever *day* of the *week* you would know what *Planetary hour* it is, the first *Planetary hour* of that *day* or *night* is called by the *Planetary name* of that *day* of the *week*; as, if it be *Monday*, then *Luna* governs the first *Planetary hour* that *day* and *night*; if *Sunday*, *Sol*; if *Wednesday*, *Mercury*, &c.

I. To finde the length of a *Planetary hour* at any time.

Practice.] For the *day* proposed, (after you have

have rectified the *Globe* to the *Latitude*, &c.) bring the *Suns place* in the *Ecliptick* for that day to the *East-side* of the *Horizon*, and see what degree of the *Equinoctial* is cut by the *Horizon*; then bring the *Suns place* to the *Meridian*, and then again see what degree of the *Equinoctial* is then cut by the *Horizon*: the difference of those degrees being divided by Six, because there are 6 *Planetary hours* between Sun-Rising and our 12 at noon (which is always the *Sixth Planetary hour*) and that Quotient shall be the number of minutes contained in a *Planetary hour* all that day. Thus for Example, on *Tuesday* the 27 of *July* 1675, the *Suns place* will be found to be in 14 deg. of *Leo*; bring 14 deg. of *Leo* to the *East-part* of the *Horizon*, and you shall finde that 115 deg. of the *Equinoctial* are (at that time) cut by the *Horizon*; which degrees note down, or mark upon the *Globe*. — Then bring 14 deg. of *Leo* to the *Meridian*, and then you shall finde 226 deg. of the *Equinoctial* cut by the *Horizon*; so that if you take with your *Compasses*, or count the number of degrees of the *Equinoctial* contained between 115 deg. and 226 deg. you shall finde them to be 111 deg. [or if you subtract 115 from 226, which is easiest, the difference will be 111 also] and so many degrees of the *Equinoctial* do pass the *Meridian* in *Six Planetary hours*: Wherefore divide 111 by 6, and in the Quotient you shall finde 18 deg. 30 min. to pass th. *Equinoctial* in *One Planetary hour*; and so counting 15 deg. for 1 hour, and 1 deg. for 4 min. of time, you shall finde the *length* of the *Planetary hour* to contain *One Common hour* and

14 min.

14 min. more, which is one hour and a quarter wanting one minute. — And the length of a *Planetary hour* for the *night* will contain only 46 min. which is less than *One Common hour* by a quarter wanting one minute.

II. To finde what *Planetary hour* of the day or night it is.

On the forementioned day, *Tuesday* the 27 of *July* 1675, Let it be required to know what *Planet* ruleth that day at 5 of the clock in the afternoon. The length of the *Planetary hour* for that day is 1 hour 14 min. Wherefore, the *Globe* being Rectified, bring the *Index* of the *Hour-circle* to 5 a clock, and then count the number of degrees which were cut by the *Horizon* in the last operation, and the degrees of the *Equinoctial* now at the *Horizon*, and you shall finde them to be 187 deg. which reduced into minutes of time (by multiplying them by 4) gives 748, which 748 min. being divided by 74, the number of minutes contained in one *Planetary hour*, the Quotient will be 10 hours and 8 min. shewing that there are 10 *Planetary hours* past, since the Sun-Rising, and that there are 8 min. of the Eleventh hour past also.

III. To finde what Planet governeth that hour of the day.

For the effecting hereof, the *Globe* standeth you in no stead at all; wherefore observe the *Table* following and its *Use*.

The TABLE.

Governours of the day.	Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.	Governours of the night.
Sol.	1	12	9	0	10	0	11	Jupiter.
Venus.	2	0	10	0	11	1	12	Mars.
Mercury.	3	0	11	1	12	2	0	Sol.
Luna.	4	1	12	2	0	3	0	Venus.
Saturn.	5	2	0	3	0	4	1	Mercury.
Jupiter.	6	3	0	4	1	5	2	Luna.
Mars.	7	4	1	5	2	6	3	Saturn.
Sol.	8	5	2	6	3	7	4	Jupiter.
Venus.	9	6	3	7	4	8	5	Mars.
Mercury.	10	7	4	8	5	9	6	Sol.
Luna.	11	8	5	9	6	10	7	Venus.
Saturn.	12	9	6	10	7	11	8	Mercury.
Jupiter.	0	10	7	11	8	12	9	Luna.
Mars.	0	11	8	12	9	0	10	Saturn.

The use of the aforesaid Table.

Having by former Rule found what Planetary hour it is, if you would know what Planet it is that Reigneth that hour, in the head of this Table seek the day of the week (in this Example Tuesday) and the Planetary hour of the day (in this Example 10 hours in the Forenoon :) in the same Column, and right against it in the first Column on the left hand, you shall finde Venus, which shews that at 5 of the clock in the afternoon that day Venus governeth, and hath governed 8 min. of her hour.

Also in the same Table you shall finde against 10 under Tuesday in the last Column towards the right hand, the word Mars, shewing that Mars governeth the 10th Planetary hour for the night, and hath governed 8 min. of his hour.

POST-

POSTSCRIPT.

FOrasmuch as the two first Sections of the foregoing Problem are for the more part performed by Arithmetical computation, and not Globular Operation; I have (for that it may be satisfactory to some persons) added a Table, whereby, if you know but at what hour the Sun riseth at any time of the year, you may know readily the length of the Planetary hour, and also at any Common hour of the day or night, what Planetary hour it is, and also what Planet ruleth that hour.

A T A B L E,

Shewing the length of

The PLANETARY HOUR

For any hour of the Day or Night

At any time of the Year, &c.

Planetary hours

In the Forenoon.

☉ Ril.	I	II	III	IV	V	VI
H. M.	b. m.	b. m.	b. m.	b. m.	b. m.	H.
6 0	7 0	8 0	9 0	10 0	11 0	12
5 47	6 50	7 52	8 54	9 56	10 58	12
5 35	6 39	7 43	8 48	9 52	10 56	12
5 22	6 28	7 35	8 41	9 47	10 54	12
5 10	6 18	7 27	8 35	9 43	10 52	12
4 57	6 8	7 18	8 29	9 39	10 50	12
4 45	5 58	7 10	8 23	9 35	10 48	12
4 34	5 48	7 3	8 17	9 31	10 46	12
4 23	5 39	6 55	8 12	9 28	10 44	12
4 12	5 30	6 48	8 6	9 24	10 43	12
4 2	5 23	6 42	8 2	9 21	10 40	12
3 55	5 16	6 37	7 58	9 18	10 39	12
3 48	5 10	6 32	7 54	9 16	10 38	12
3 43	5 6	6 29	7 53	9 14	10 37	12
3 40	5 3	6 27	7 50	9 13	10 36	12
6 0	7 0	8 0	9 0	10 0	11 0	12
6 13	7 11	8 9	9 7	10 4	11 2	12
6 25	7 21	8 17	9 13	10 8	11 4	12
6 38	7 30	8 24	9 19	10 13	11 6	12
6 50	7 42	8 23	9 25	10 17	11 8	12
7 3	7 53	8 42	9 32	10 20	11 10	12
7 15	8 3	8 50	9 38	10 25	11 12	12
7 26	8 12	8 57	9 43	10 29	11 14	12
7 37	8 21	9 5	9 49	10 34	11 16	12
7 48	8 30	9 12	9 54	10 36	11 18	12
7 57	8 38	9 18	9 59	10 39	11 20	12
8 5	8 44	9 23	10 4	10 41	11 21	12
8 12	8 50	9 28	10 6	10 45	11 22	12
8 17	8 54	9 31	10 9	10 46	11 23	12
8 20	8 58	9 34	10 10	10 46	11 24	12

for the Day.

In the Afternoon.

© Rif.	VII	VIII	IX	X	XI	XII.
H. M.	b. m.	b. m.	b. m.	b. m.	b. m.	b. m.
6 0	1 0	2 0	3 0	4 0	5 0	6 0
5 47	1 2	2 4	3 6	4 8	5 10	6 13
5 35	1 4	2 8	3 13	4 17	5 21	6 25
5 22	1 6	2 13	3 19	4 25	5 32	6 38
5 10	1 8	2 17	3 25	4 33	5 42	6 50
4 57	1 11	2 21	3 32	4 42	5 43	7 3
4 45	1 13	2 25	3 38	4 50	6 6	7 15
4 34	1 14	2 29	3 43	4 57	6 12	7 26
4 23	1 16	2 32	3 49	5 5	6 21	7 37
4 12	1 18	2 36	3 44	5 12	6 31	7 48
4 2	1 20	2 39	3 59	5 18	6 38	7 57
3 55	1 21	2 42	4 3	5 23	6 44	8 5
3 48	1 22	2 44	4 6	5 28	6 50	8 12
3 43	1 23	2 46	4 9	5 31	6 54	8 17
3 40	1 24	2 47	4 10	5 33	6 57	8 20
6 0	1 0	2 0	3 0	4 0	5 0	6 0
6 13	1 58	2 56	2 54	3 51	4 49	5 47
6 25	1 56	2 50	2 48	3 43	4 39	5 35
6 38	1 54	2 47	2 41	3 35	4 28	5 21
6 50	1 52	2 43	2 34	3 37	4 18	5 10
7 3	0 50	1 39	2 29	3 18	4 8	4 57
7 15	0 48	1 35	2 23	3 10	3 58	4 45
7 26	0 46	1 31	2 17	3 3	3 48	4 38
7 37	0 44	1 28	2 12	2 55	3 39	4 21
7 48	0 43	1 24	2 6	2 48	3 30	4 13
7 57	0 41	1 21	2 2	2 42	3 23	4 3
8 5	0 39	1 18	1 57	3 6	3 15	3 55
8 12	0 38	1 16	1 54	3 2	3 10	3 48
8 17	0 37	1 14	1 51	2 8	3 5	3 43
8 20	0 36	1 13	1 49	2 27	3 3	3 40

Planetary hours

Before Midnight.

© Rit.	I	II	III	IV	V	VI
H. M.	b. m.	b. m.	b. m.	b. m.	b. m.	H.
6 0	7 0	8 0	9 0	10 0	11 0	12
5 47	7 11	8 9	9 7	10 4	11 2	12
5 35	7 21	8 17	9 13	10 8	11 4	12
5 22	7 30	8 25	9 19	10 13	11 6	12
5 10	7 42	8 33	9 25	10 17	11 8	12
4 57	7 53	8 42	9 32	10 21	11 10	12
4 45	8 3	8 50	9 38	10 25	11 12	12
4 34	8 12	8 57	9 43	10 29	11 14	12
4 23	8 21	9 5	9 49	10 32	11 15	12
4 12	8 30	9 12	9 54	10 36	11 18	12
4 2	8 38	9 18	9 59	10 39	11 20	12
3 55	8 44	9 23	10 2	10 41	11 21	12
3 48	8 50	9 28	10 6	10 44	11 22	12
3 43	8 54	9 31	10 9	10 45	11 23	12
3 40	8 57	9 33	10 10	10 47	11 23	12
6 0	7 0	8 0	9 0	10 0	11 0	12
6 13	6 47	7 51	8 54	9 56	10 58	12
6 25	6 39	7 43	8 48	9 52	10 56	12
6 38	6 28	7 35	8 41	9 47	10 54	12
6 50	6 18	7 27	8 35	9 43	10 52	12
7 3	6 8	7 18	8 29	9 39	10 50	12
7 15	5 58	7 10	8 23	9 35	10 48	12
7 26	5 48	7 3	8 17	9 31	10 46	12
7 37	5 39	6 55	8 12	9 28	10 44	12
7 48	5 30	6 48	8 6	9 24	10 42	12
7 57	5 23	6 42	8 2	9 21	10 41	12
8 5	5 16	6 37	7 58	9 18	10 39	12
8 12	5 10	6 32	7 54	9 16	10 38	12
8 17	5 6	6 29	7 52	9 14	10 37	12
8 20	5 3	6 27	7 50	9 13	10 36	12

for the Night.
After Midnight.

© Rif.	VII	VIII	IX	X	XI	XII.
H. M.	b. m.	b. m.	b. m.	b. m.	b. m.	b. m.
6 0	1 0	2 0	3 0	4 0	5 0	6 0
5 47	1 58	1 56	2 54	3 51	4 41	5 47
5 35	1 56	1 52	2 48	3 43	4 39	5 35
5 22	1 54	1 47	2 41	3 35	4 28	5 22
5 10	1 52	1 43	2 35	3 27	4 18	5 10
4 57	0 50	1 39	2 29	3 18	4 8	4 57
4 45	0 48	1 35	2 23	3 10	3 58	4 45
4 34	0 46	1 31	2 17	3 3	3 48	4 34
4 23	0 44	1 28	2 12	2 55	3 39	4 23
4 12	0 42	1 24	2 6	2 48	3 30	4 13
4 2	0 41	1 21	2 2	2 41	3 23	4 3
3 55	0 39	1 18	1 57	2 36	3 15	3 55
3 48	0 38	1 16	1 54	2 32	3 10	3 48
3 43	0 37	1 15	1 51	2 28	3 5	3 43
3 40	0 37	1 14	1 50	2 27	3 3	3 40
6 0	1 0	2 0	3 0	4 0	5 0	6 0
6 13	1 2	2 4	3 7	4 9	5 11	6 13
6 25	1 4	2 8	3 13	4 17	5 21	6 25
6 38	1 6	2 13	3 19	4 25	5 32	6 38
6 50	1 8	2 17	3 25	4 33	5 42	6 50
7 3	1 11	2 21	3 32	4 43	5 53	7 3
7 15	1 13	2 25	3 38	4 50	6 3	7 15
7 26	1 14	2 29	3 44	4 57	6 12	7 26
7 37	1 16	2 32	3 49	5 5	6 21	7 37
7 48	1 18	2 36	3 54	5 12	6 30	7 48
7 57	1 20	2 39	3 59	5 18	6 38	7 57
8 5	1 21	2 42	4 2	5 23	6 44	8 5
8 12	1 22	2 44	4 6	5 28	6 50	8 12
8 17	1 23	2 46	4 9	5 31	6 54	8 17
8 20	1 24	2 47	4 10	5 33	6 57	8 20

The Table described.

EACH Page of the *Table* consisteth of 7 *Columns*: in the first *Column* of each Page, towards the *left hand*, is placed the time of the *Suns Rising*, and in the *Six* subsequent *Columns* are placed the beginnings and continuances of of the *Planetary hours*. — The first of the four Pages contain the *Six Planetary hours* for the *Day*, viz. I, II, III, IV, V, and VI, from *Sun-rising* to *Noon*. — The second Page contains the other *Six Planetary hours* for the *Day*, viz. VII, VIII, IX, X, XI, and XII, from *Noon* to *Sun setting*. — The third Page contains the first *Six Planetary hours* for the *Night*, viz. the I, II, III, IV, V, and VI, from *Sun-setting* till *Midnight*. — And the fourth Page contains the other *Six Planetary hours* for the *Night*, viz. the VII, VIII, IX, X, XI, and XII, from *Midnight* till *Sun-rising* the next Morning. Thus much for the *Description*. Now followeth

The Use of the Table.

LET it be required to finde what *Planet Ruleth* upon *Friday* the 27 of *March*, at 10 of the clock in the Forenoon.

First, You must finde the time of the *Suns Rising* for the day proposed, by the *Astronomical Problem* for that purpose; which you shall finde to be at 22 min. after 5 in the Morning.

Second-

Secondly, Finde this 5 hours and 22 min. in the first Column towards the left hand, and look along that line towards the right hand, and you shall finde under the first Planetary hour 6 hou. 28 min. which is the time of the first Planetary hour; under the second, 7 hou. 35 min. for the third 8 hou. 41 min. &c. Now, because 10 of the clock is the time that I require the Planetary hour, I continue looking along that line, till I finde 10 of the clock, and I finde 10 hou. 54 min. to stand under the fifth Planetary hour; which shews that it is the fifth Planetary hour, and that that hour did begin at 47 min. after 9 of the clock, and will continue till 54 min. after 10 of the clock.

Now to know what Planet it is that Rulesh at that time, repair to the foregoing Table, and finde Friday in the head thereof, and the Common hour of the day given (in our Example 10.) under Friday; and right against 10 towards the left hand, you shall finde Luna, which sheweth that Luna Rules, and will continue Ruling till 54 min. after 10 of the clock.

The like is to be understood of all the rest; and if it be the Night-hour, in the little Table you must finde the name of the Ruling Planet on the right hand of the Table.

Note, That if you cannot finde the very exact time of Sun-rising in the Table, you must make use of that which is neerest to it, which will be sufficient for this purpose.

GEOGRAPHY AND NAVIGATION

Made easie :

OR,

A plain Description and Use of the
Terrestrial GLOBE.

INTRODUCTION.

THe *Terrestrial or Earthly Globe* is an artificial Representation of the Earth and Water under that form and figure of roundness which they are known to have describing the Scituations, and measuring the distances of all their parts.

The Land drawn out upon a *Globe*, is bounded and distinguished from the Water with an irregular line which runs turning and winding into Creeks and Angles like as the shoar which it represents: that side which is left uncoloured, is the limits of the water; the other side of the Line which encircles the Colours, is the bounds of the Land, which is either Continent or Island.

A *Continent* is a great quantity of Land not environed or separated by the Sea, in which many Kingdoms and Countries are contained; as

Europe, Asia, &c. An *Island* is a part of the Earth clasp'd in the embraces of the Sea, and hoopt as it were with a watery Girdle, as *Great Britain* and *Ireland*. These again are subdivided into *Peninsula's*, *Isthmus's*, *Promontories*, *Capes*, &c. A *Peninsula* or *Pene-Insula* is a part of Land which being almost environed and encompassed round with water, is joyned to the firm Land by some little *Isthmus*, as *Africa* is joyned to *Asia*, or *Morea* to *Greece*. An *Isthmus* is a little narrow neck of Land betwixt two Seas, joyning a *Peninsula* to the *Continent*; as that of *Darien* in *America*, or *Corinth* in *Greece*. A *Promontorie* is *Mons in Mari prominens*, a high Hill or Mountain lying out as an Elbow of land into the Sea, the utmost end of which is called a *Cape*; as the *Cape of Good Hope*, and *Cape Verde*.

The Land drawn upon the Superficies of the *Terrestrial Globe*, is divided in four principal Parts or Quarters, viz. *Europe, Asia, Africa, and America*.

OF EUROPE.

Europe as it is now divided, contains these

Kingdoms or States.	Cities.	Rivers.
England.	London, York, Oxford, Cambridge, Canterbury, Bristol.	Thames, Severn, Humber, Trent.
Scotland.	Edenburgh, St. Andrews.	Tweed, Froth, Tay.
Ireland.	Dublin, Waterford, Galloway, Limerick.	Shannon Shure, Blackwater, Barrow
France.	Paris, Lyons, Orleans, Bourdeaux, Toulouse, Aix.	Seine, Loire. Garone, Rhone.
Spain.	Madrid, Siville, Toledo, Saragossa.	Ebre, Gaudalquivir. Gaudiana, Douro.
Portugal.	Lisbon, Braganza.	Tagus.
Belgia, or the 17 Provinces.	Amsterdam, the Hague, Antwerp, Brussels.	Meuse, Iſel, Lis, Eschant.
Italy.	Rome, Florence, Venice, Naples, Genoa, Milan.	Po, Arne. Tiber.
Savoy.	Chambery, Turin.	Dore, Liffre.
The Swiſſes.	Geneve, Basel, Zurich.	Rus, Aar.
Denmark.	Copenhagen, Slawick, Bergen, Christiane.	Sley, Eyder.
Sweden.	Stockholm, Gottenburg, Upsal, Calmer.	Wenar, Vetter.
Poland.	Cracovia, Dantzick, Vilna, Warzovia.	Duna, Neimen, Vistula, Neiper. Neister, Bog.
The Empire of Germany.	Pienna, Nuremberg, Hambrough, Prague, Cölln, Heidelberg.	Danube, Elbe. Rhine, Weser. Oder.
Russia.	Moscow, Novogrod, Arch-Angel, Smolensko.	Wolga, Dwina.
Turky in Europe.	Constantinople, Belgrade, Adrianople, Saloniche.	Tanais, Boristenes. Danube, Dravus.
Parte Tartaria.	Cers and Cassa.	Savus, Tebisus.
Islands.	Great Britain, Ireland, Wight, Man, Zeland, Can- dia, Sicilly, Sardinia, the Hebrides, Orcades, &c.	

OF ASIA.

Asia as it is now divided, contains these

Empires or Countries.	Cities.	Rivers.
The Turkish Empire.	Aleppo, Smyrna. Damascus, Jerusalem, Bagdat, Mosul.	Tigris. Euphrates.
Georgia.	Faz, Teflis.	Fazis, Kur.
The Arabians.	Macca, Medina, Anna, Mocha.	Chaiber, Nageran.
The Persian Empire.	Isfahan, Casbin, Tauris, Suras, Herrabat, Herat.	Teus, Pulimalon, Ilment, Brandemer.
The Mogul Empire.	Agra, Lahor, Delli, Amadabat, Cambaja, Suras.	Iudus, Ganges, Jewini, Guenga.
India within Ganges.	Goa, Calicut, Cochin, Negapatan, Narfoga, Golconda, Mazulpatan.	Ganges.
India without Ganges.	Pegue, Sian, Mallaca, Cambodia.	Ganges, Caor, Ava, Martaban.
Tartaria.	Astracan, Sarmachand, Cascar, Balch, Tauchut.	Oxas, Chefel, Obey.
China.	Pekin, Canton, Nanking, Hanchen.	Croceus, Ta, Kiang.
Japan.	Meaco, Jedo, Fivando, Nanyo laque.	
Islands.	The Maldives, Ceylon, Sumatra, Java, Borneo, Celebes, the Philippines, and the Molucces.	

OF AFRICA.

Africa as it is now divided, contains these

Parts or Countries.	Cities or principal places.	Rivers.
Barbary.	Fez, Morocco, Salle, Tanger, Algier, Tunis.	Saba, Tenis, Sus, Ounirabib.
Egypt.	Caire, Alexandre, Rossette, Damiette.	Nilus.
Misulgerid.	Segelmiss, Taradant, Biledulgerid, Dara.	Ghir.
The Deserts of Sarra.	Zanbaga, Zweriga, Terga, Lempta, Berada.	Ghir.
The Land of the Blacks.	Tombola, Agades, Borno, Zazara.	Niger, Senega, Gambia, Grande.
Kingdom of Nubie.	Nubie, Darga, Dancala, Gorham.	Nilus, Ghira.
Ginnet.	St. George de la Mine, Capr, Cora, Settera, Benin.	Sweiro, Manca, Calabar, Benin.
Ethiopia.	Amaru, Cazuma, Cafales, Arquito.	Nilus.
Conge.	St. Salvador.	Zaire, Coanza, Congo.
Cassares.	Cafala, Mono, Motapa, Cape of Good Hope.	Spirito Sancto, Rio d'Infanta.
Zanguabar.	Mosambique, Quilo, Mombaza, Melinde, Adal.	

The Maderas, Canaries, Cape Verde, St. Hela-
na, Madagascar, Bahelmandel, Zocotora, Mal-
ta, &c.

OF AMERICA.

America as it is now divided, contains these

Parts or Countries.	Cities or principal places.	Rivers.
The Coast of the N. W. passage.	St. John's Island, Port Charles.	Prince Ruperts Riv.
Canada, or Nova Fraecia.	Quebeck, Brest, Harours, Port-Royal.	Canada.
New Engl. and New York.	Boston, Plymouth, New York, Albany.	Hudsons, Connecticut.
Maryland and Virginia.	St. Marys, James Town.	Marimack, Rappahannock.
Carolina and Florida.	Charles Town, St. Matthew.	Albemarle, Ashley, Clarendon, Cooper.
New Mexico.	New Mexico.	R. del Norte.
New Spain.	Mexico, Valladolid, St. Jago, Gaudalejara.	Panuco, Barahia, Quicatulca, Sal.
Castilladel, or Panama.	Panama, Porto Bello, Cartagena, St. Martha.	St. Martha, St. Magdalen.
Guiana.	Manoa, St. Thome.	Oronoq; Surinam, Wiapoca.
Peru.	Lima, Casco, Potosi, La plaza.	Maragnon, Patime.
Chili.	St. Jago, Imperial, Baldivia.	Copayapo.
The Country of the Amazons.	Homagus, Yotimans, Topinamber, Coropa.	Topacalma, Amazons.
Paraguay.	Buenos Ayres, Ciudad Real, St. Jago, Esterco.	Rio de plata, Peruna.
Brazil.	Pairaba, Pirmambuco, Baba, Spirito Sancto.	Grande S. Francis, Ilheos, Janiero.
Islands.	Hispaniola, Cuba, Jamaica, New-found-land, the Cariber-Islands, Long Island, Magellan Island, &c.	

And thus much shall serve for the Description of the Land upon the Terrestrial Globe.

Of Water and its Parts.

THe Earth (as was said before) is encompassed about with the Water, which is either *Ocean, Seas, Straits, Creeks, Lakes, or Rivers.*

The *Ocean* is a general Collection or Rendezvous of all waters.

The *Sea* is a part of the *Ocean*, and is either Exterior, lying open to the shore, as the *British* or *Arabian Seas*; or Interior, lying within the Land, to which you must pass through some *Straits*, as the *Mediterranean* or *Baltick Seas*.

A *Straits* is a narrow Part or Arm of the *Ocean*, lying betwixt two shores, and opening a way into the *Sea*, as the *Straits of Gibraltar*, the *Hellespont*, &c.

A *Creek* is a small narrow part of the *Sea* that goeth up but a little way into the Land, otherwise called a *Bay*, a *Station* or *Road* for Ships.

A *Lake* is that which continually retains and keeps water in it, as the *Lake Nicargua* in *America*, and *Zaire* in *Africa*.

A *River* is a small Branch of the *Sea* flowing into the Land, courting the Banks while their Arms display to embrace her silver Waves.

Of the Names of the Ocean.

First of all, according to the four Quarters it had four Names; from the East it was called the *Eastern-Ocean*, from the West the *Western*, from the North the *Northern*, and from the South the

the Southern. But besides these more general Names, it hath other particular appellations, according to the Regions or Countries it boundeth upon, and the Nature of the Sea: viz. as it lies extended toward the East, it is called the *Chinean Sea* from the adjacent Country of *China*; so the *Archipelago* of *St. Lazarus*, from the multitude of Islands. Toward the South, 'tis called *Oceanus Indicus*, or the *Indian Sea*, because upon it lies the *Indians*. The *Gulph of Bengala*, from *Bengala* a City in the *Indies*. Where it touches the Coast of *Persia*, it is called *Mare Persicum*: so also *Mare Arabicum*, from *Arabia*; so towards the West, is the *Aethiopian Sea*. Then the *Atlantick Ocean*, from *Atlas* a Mountain or Promontory in *Africa*; by the *Spaniards* called *Mar del sur*, as also *Mare Pacificum*; and on the other side of *America* is called by them *Mar del Nort*. Where it touches upon *Spain*, it was called *Oceanus Cantabricus*, now the Bay of *Biscay*. The Sea between *England* and *Fraunce* is called the *Chanel*; between *England* and *Ireland*, the *Irish Sea*, by some *St. George's Chanel*: between *England* and *Holland*, it is called by some the *German Ocean*, by others the *Brittish Seas*; *Vulgo*, the *Narrow Seas*: beyond *Scotland* it is called *Mare Caledonium*; higher towards the North, it is called the *Hyperborean* or *Frozen Sea*; more Eastward upon the Coast of *Tartaria*, the *Tartarian Sea*, &c. And this shall suffice concerning the *Ocean*, or Exterior Seas.

The

The Names of the Inland Seas.

THE *Baltick Sea*, of old *Sinus Codanus*, by some called the *East-Sea*, by the Inhabitants the *Belt*, lying between *Denmark* and *Sweden*, the entrance whereof is called the *Sound*.

Secondy, The *Euxine Sea*, or the *Black Sea*, by some *Mare Caucasium*, *Scythicum*, *Sarmaticum*, *Colchicum*; by the *Turks*, *Caradinizi*; to which joyns *Meosis Palm*, now *Mar de Zabacken*.

The third, is the *Caspian* or *Hircanian Sea*; by the *Turks*, *Mar de Sala*; by the *Persians*, the *Sea of Backs*; by the *Moscovites*, *Chwaleuskei Mare*. The length is from *North* to *South*, and the breadth from *East* to *West*, contrary to all the Antient Geographers; which is certainly discovered, not only by the exact observation of *Olearius*, but also by his curious enquiries of the true Situation of its Maritime places according to the Longitude and Latitude of the *Persians*, as also by the *Astronomical Calculations* of *Mr. Graves*, &c.

The fourth, is the *Arabian Golph*, *Mare Erythraeum*, or *Rubrum*, *Vulgo* the *Red-sea*; by others *Mare Rosso*, and *Mar de Mecca*.

The fifth, is the *Persian Golph*, or the *Golph de Elcatife*.

The sixth, is *Mare Mediterraneum*; by the *English*, the *Straits*; by the *Spaniards*, *Mar de Levant*: the beginning or entrance of it is called the *Straits of Gibraltar*, rather *Gibraltorec*, olim *Gaditanus*. This Sea hath many names, as it toucheth upon several Countries; the particular account

Count whereof I shall refer to *Geographical Description of Maps, &c.* The length of it is by our *New Globes* not, 37 deg. of the *Equinoctial* from *Tanger* to *Scanderone*: by other *Globes* and *Maps* it is more than 42 deg. of the *Equinoctial*. And this shall suffice for a Description of the Water, and its Parts.

Now that all Places, Cities, Towns, Seas, Rivers, Lakes, &c. may be readily found out upon the *Globe*, all *Geographers* do or should place them according to their *Longitude* and *Latitude*: the use of which in the absolute sense, is to make out the position of any place in respect of the whole *Globe*, or to shew the Situation and distance of one place from & in respect of any other.

An Advertisement concerning Longitude.

To say the truth, by reason of the variety of *Meridians*, the *Longitudes* are grown to such an uncertainty and confused pass, that 'tis not every mans work to set them down. This indeed I have observed, that many *Geographers*, or rather describers of particular places, tell us that such a place is so many degrees of *Longitude*; but from what *Meridian*, others must guess. Some particularly profess to follow *Mercator*: but what are most men the wiser for this? for *Mercator's Meridian* was not always the same; sometimes through the *Canary Islands*, sometimes through the *Azores*. Others again will tell you their *Meridian* shall pass through the *Azores*; but whether from that of *St. Michael*, or that of *Corvo*, is not set down; and yet 6 deg.

of difference. I shall therefore take this course: First, set down the several Meridians observed. Secondly, the difference of Longitude betwixt these Meridians. Lastly, which of these I have first upon.

1. The Great Meridian by Ptolomy and most of the ancient and Greek Geographers was made to pass through *Jannonca* one of the Fortunate, now thought to be the Canary Islands.

2. By the Arabian and Nubian Geographers through the utmost point of the Western shore neer *Hercules Pillars*.

3. *Ortelius* in his sheet-Europe makes London to lie in 28 deg. of Longitude; but in the Sheet-maps of France and Belgia it lies in but 21 deg. so that his first Meridian to me is yet unknown. The Spaniards since the Conquest of the West-Indies, contrary to all other, account their Longitude from East to West, beginning at Toledo.

4. Our Modern Geographers, as *Mercator*, *Cambden*, *Speed* and others, removed it into the Azores; some placing it at *St. Michaels*, others at *Corvo*.

5. *Blaeu* the Dutch Geographer begins his Longitudes from *Tenerif* one of the Canary Islands; but upon his Great Map, the Great Meridian passeth through *Tercera-Isle*, one of the Azores; which the rest of their Common Map-makers, *De Wit*, *Visher*, &c. as well as many of our English, are bound to follow through ignorance, transcribing as well his Errours as his Copies for the best.

6. *Sanfon* the French Geographer, for some Rea-

Reasons (best known to himself) begins his *Longitudes* at *Ferro* one of the *Canary-Islands*; and therefore *Blome* his Translator is bound to follow it, though possibly he cannot tell so much, and yet the Kingdoms great pretender to *Geography*.

7. The English *Hydrographer* tells us, that with a great deal of Reason and Consideration he placed his first *Meridian* at *Graciosa* one of the Islands of the *Azores*; but it is delineated upon his *Globes* and *Maps* through *Tercera*, almost 2 deg. more *Eastward*: a small mistake, that another must come after him to tell himself what *Meridian* he went by.

Secondly, The differences of these several *Meridians* I finde are thus stated.

From *Ptolomies Meridian* to the *Arabian Meridian* was by *Abalseda* in his Introduction to his *Geography* accounted to be 10 deg. of the *Equator*; *Brier* saith but 8 deg.

		d. m.		
From the vic of Trarife to	Toledo	{	15. 55	the Spanish.
	Graciosa		10. 25	the mistaken Engl.
	Tercera		9. 0	the supposed Dutch
	Palma or Ferro		2. 5	the French
	Corvo		13. 25	Mercator or 0.
	St. Michael		8. 5	thers
		Meridian.		

And this last is the *Meridian* from which the *Longitudes* are reckoned in the new *Terrestrial Globe*, and in *several Maps* that are lately set forth by the Publishers of this Book.

Geographical Problems.

PROB. I.

To finde the Longitude.

Defini- **L**ongitude is the distance of a place
tion.] from the first Meridian reckoned in
the degrees of the Equator, beginning, as was
said, in this New Terrestrial Globe, at St. Michaels
Island in the Azores.

Practice.] Bring the place (that is, the mark
of the place) suppose London, to the Brassen Me-
ridian; then count how many degrees of the E-
quator are contained between the first Meridian
and that of London cut by the Brassen Meridian,
which you will finde to be 28 deg. which is the
Longitude required. And in this manner you
shall finde

	d.	m.
London	28	0
Jerusalem	66	30
Fedo in Japan	167	0
Rio de la plata	32	0
Mexico	75	0
Charlton Ile	51	30

	d.	m.	
	26	0	
	73	30	
By other Globes	178	0	reckoned from the
and Maps	21	0	same Meridian.
	86	0	
	65	50	

PROB.

PROB. II.

To finde the Latitude of a place.

Definition.] The Latitude of a place, is the distance of the Equator from the parallel of that place, reckoned in the degrees of the Great Meridian; and is either North or South, according as it lies between the North or South-poles of the Equator.

Practice.] To finde the Latitude, bring the mark of the place, for example, suppose London, to the Brazen Meridian; then count the number of degrees upon the Meridian, contained between the Equator and the place given. Thus, you shall finde the Latitude of

	d. m.		d. m.
London to be	51.30		51.30
Labor in the Moguls			
Country to be	31.30	By	23.30
The South-part of the		ther	
Caspian Sea to be	37. 0	Globes	41. 0
African, on the Nor. part		and	
of the Caspian Sea to be	46. 0	Maps	49. 0
The North-part of China			
to be	42. 0		52. 0
Delli in India to be	28. 0		21. 0

PROB.

PROB. III.

The Longitude and Latitude of any place being known, to finde the true Scitnation of it, though not expressed upon the Globe.

Practice. **B**Ring the degree of the Equator that answereth to the Longitude of the place to the Meridian, and then reckon the Latitude of the place upon the degrees of the Meridian towards either Pole according as it is either North or South Latitude, and right under that degree and minute upon the Meridian, is the true Scituation of the place enquired after.

PROB. IV.

To finde what time or hour of the Day or Night it is in any part of the Earth.

Defini- **B**Y reason of the earths diurnal motion.] **B**on round the Sun in 24 hours, the Sun enlightning but one half of it at the same time, it comes to pass that when it is Morning in one place, it is Noon in a second, Night in a third, and Midnight in a fourth, according to their several Scituations in respect of East and West one from the other. This difference of time is known by the number of degrees contained in
P the

the *Equator* between any two places proposed converted into hours and minutes, reckoning 15 deg. to an hour, &c. but more readily by the *Globe* thus :

Practice.] Suppose at *London*, at 12 of the clock at Noon, you would know what a clock it is at *Mexico* in the *West-Indies*; bring *London* to the *Meridian*, and set the *Index* of the Hour-circle to 12. then turn the *Globe Eastward*, because *London* is East of *Mexico*, till you bring *Mexico* to the *Meridian*; then see what hour the *Index* points at, for that is the hour then at *Mexico*. Thus you will finde,

		b.	m.	
when it	<i>Mexico</i>	5	10	a clock
is 12 a	<i>Charlton Island</i>	6	45	before
clock	<i>Rio de la plata</i>	8	10	Noon.
at Lon-	<i>Jerusalem</i>	2	35	a clock
don, it	<i>Surrat</i>	5	15	after
is at	<i>Jedo</i>	9	18	Noon.

And thus by knowing what difference of time there is between place and place at 12 a clock, the like difference is to be understood of all other hours.

PROB.

PROB. V.

To finde the distance of any two places upon the Globe one from another.

Practice.] **L**ay the *Quadrant of Altitude* upon both the places required: then count the number of degrees of the *Quadrant of Altitude* contained between the two places: which being found, multiply them by 60, gives the distance in English Miles. Thus you will finde

		d. m.		d. m.	
The distance of London from	Mexico	81.30	by our new size of Globes.	91.30	by the great Dutch Globes and English.
	Jerusalem	33.30		38. 0	
	Surrat	65.50		71.40	
	Jedo	85.10		92.30	
	Rio de la plata	100.20		106. 0	
	Charlton Island	46.20		54. 0	

If you finde (as you needs must) that the proportion of Miles upon these new *Globes* do very much differ from those distances set down by other Authors, you are desired not to think much: for the *Longitudes* are not yet exactly agreed on: the perfection is not one mans, nor one ages work, and must be waited for. Where you finde the places upon this *Globe* to agree with others, you have cause to suspect they have lain upon the

lees of time, not as yet inquired into : where you finde them to disagree, you may conclude that they have been brought to a truer correction and amendment.

PROB. VI.

To finde the Position, or what Point of the Compass any two places are Scituate one from another.

Defini- **T**He Position is an *Angle* which is made *tion.* by the meeting of the *Meridian* of one place, with the *Vertical Circle* of another.

Practice. To finde this out, you are to elevate the *Pole* to the *Latitude* of one of the places, suppose *London* ; then bring it to the *Meridian*, and it will fall out to be directly in the *Zenith*, for the *Elevation* is always equal to the *Latitude* ; then fasten the *Quadrant of Altitude* to the *Zenith*, and turn it about till it fall upon the other place, suppose the *Ile of Tenerif*, and the end of the *Quadrant* where it toucheth the *Horizon* will shew that the *Ile Tenerif* beareth from *London* S S W : so also the bearing of *Barbadoes* from the *Lizard* to be S W, half a point *Westerly* ; and the opposite point N E, half a point *Easterly*, the bearing of the *Lizard* from the *Barbadoes*.

PROB.

PROB. VII.

To know at any time in what place of the Earth the Sun is in their Zenith.

This must be to such Inhabitants of the Earth only that inhabit in the *Torrid Zone* between the *Tropicks*.

Practice. **B**Ring the place you are in, suppose *London*, to the *Meridian*, and the *Index* to the hour 12; then consider the time of the day, which suppose to be half an hour after 5 in the afternoon, the *Sun* having then 10 deg. of *North-Declination*: then because it is afternoon, turn the body of the *Globe Eastward*, till the *Index* hath passed 5 hours and $\frac{1}{2}$, from 12, that will be to 7 a clock and $\frac{1}{2}$, and there stay the *Globe*; then see what place or Country is under the *Meridian* that cuts 10 deg. of *North Declination*, and you will finde *Nombre di dios* upon the *Isthmus* of *Panama* in the *West-Indies*. But if it were required the same day at half an hour after 6 in the Morning, then you should have turned the *Globe Westward* till the *Index* had passed 6 hours and $\frac{1}{2}$: and then under the *Meridian*, and upon the parallel of 10 deg. *North-Declination*, you will finde it neer 4 or 5 little Islands close by the *West-side* of *Mallacta* in the *East-Indies*, where the *Sun* will be in *Zenith* at that time.

Having found in what place of the Earth the

Sun is in the *Zenith*, elevate the *Globe* to the *Latitude* of the place either *North* or *South*; then bring that place to the *Meridian*, so shall all places cut by the *Horizon* have the *Sun* in their *Horizon*; those to the *Westward* shall have the *Sun* rising in their *Horizon*; those to the *Eastward* shall have the *Sun* setting. In those Countries that are above the *Horizon* it is day-light, and in those but 18 deg. below the *Horizon*, it is twilight; but in those Countries further below the *Horizon*, it is at that time midnight.

PROB. VIII.

The difference of Longitude being known, to finde what degree of the Ecliptick culminates at any other place at any time proposed.

March the 10th at 10 of the clock before noon here at London, I would know what degree of the Ecliptick culminates then at Jerusalem.

Practice. **E**levate the *Globe* to the *Latitude* of your place, viz. 51 deg. 30 min. then bring the *Suns* place for that day, viz. 7^o deg. to the *Meridian*, and the *Index* to 12. then turn the *Globe Eastward* till the *Index* point at the given hour, viz. 10 of the clock, and you will finde the 28 deg. of π then culminating here at *London*. Next turn about the *Globe Westward* until 33 deg. 30 min. of the *Equator* be passed

passed through the *Meridian*, or till the *Index* of the Hour-circle be moved 2 hours 35 min. which is the difference of *Longitude* given, and then you will finde the *Meridian* cut the *Ecliptick* at almost 4 deg. of γ : so that I say, γ 4 deg. is the point of the *Ecliptick* that is then culminating at *Jerusalem*.

P R O B. IX.

To finde out the several Positions of the Inhabitants of the Earth, the distinction of Shadows, the different Habitations, &c.

THE *Longitude* and *Latitude* of a place once resolved on, the *Position* of the *Sphere* you cannot mis of; for if the place you try for have no *Latitude*, it must of necessity lie under the *Equator*; and therefore in a *Right Position*: if it have less or more *Latitude*, the *Position* is *Oblique*; if the place have 90 deg. of *Latitude*, the *Position* is *Parallel*: the Reasons were told before, and may evidently be discerned upon the *Globe*.

For the *Climes* and *Parallels*, and consequently the length of the longest day, the fore-knowledge of the *Latitude* leadeth you directly; for they who are under the *Equator*, have their day always 12 hours, and their night 12 hours long. Now as each Country declines from the *Equator* towards either of the *Poles*, so the daies vary their length in Summer, and the nights theirs in

Winter: according therefore to the different lengthening of their daies, the Antients did distinguish the Earth into several portions or parts, which they called *Climates* and *Parallels*: every Climate contains two *Parallels*; so that where the longest daies are halt an hour longer than at the *Equator*, the first Climate begins; and where they are encreased an hour longer than at the *Equator*, the second Climate begins, which by the 20th *Problem* you will finde to be at 8 deg. 34 min. for the first, and at 16 deg. 43 min. where the second begins; and so for any of the rest.

The *Tropicks* and *Polar circles* divide the Surface of the *Globe* into 5 parts or spaces, which are called *Zents*; whereof one is contained within the *Arctick-circle*, another compassed by the *Antarctick-circle*, and are called the *Frigid Zones*; The other two lying between the *Arctick-circle* and *Tropick of Cancer*, and between the *Antarctick-circle* and the *Tropick of Capricorn*, are called the *Temperate Zones*; and the other lying between the two *Tropicks*, is called the *Torrid* or *Mid-zone*.

Knowing these, you may easily conclude upon the distinction of *Shadows*: for those of the *Frigid Zones* are termed *Periscii*, because there their *Shadows* have a *Circular motion*. Those of the *Temperate Zone* are called *Heteroscii*, because their *Meridian-shadows* bend toward either *Pole*; towards the *North* to those that dwell within the *Tropick of Cancer*, and the *Arctick-circle*; towards the *South* to those that dwell within the *Tropick of Capricorn* and the *Antarctick-circle*. The *Inhabitants* of the *Torrid Zone* were called *Amphiscii*,

iii, because the Noon-shadows according to the time of the year do sometimes fall towards the North when the Sun is in the Southern signes, and sometimes towards the South when the Sun is in the Northern signes,

To finde out the other distinction of Habitation, viz. Antæci, Periæci, Antipodes.

Let London be the place; bring it to the Meridian, where you finde it to be 51 deg. 30 min. elevated above the Equator, account so many degrees of Southern Latitude below the Equator, and you meet with the Antæci (if any be.) Remove London from the Meridian 180 deg. and you shall finde your Periæci under the Meridian where London was before, and your Antipodes is in the place where their Antæci stood before.

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NAUTICAL Problems.

INTRODUCTION.

THere be four things upon which the practice of *Navigation* is principally grounded, viz. 1. *Longitude*, 2. *Latitude*, 3. *Course*, 4. *Distance*.

As for the *Longitude*, though it may be found by the other, yet hitherto there hath not been published any general Rule true and practicable, whereby the *Longitudes* of places may be immediately and ordinarily found out of themselves.

The *Latitudes* of places may be immediately found out by observation of *Sun* or *Stars*, as shall be shewed hereafter.

The third thing to be considered in the Art of *Navigation*, is the *Course* or *Line* by which the *Ship* must go, which dependeth upon the *Winds*; the deligation of these, upon the certain knowledge of one principal, which considering the *Situations* of the *Earth*, ought to be *North* or *South*, which now is found by the *Needle* touched with the *Loadstone*, being thereby endued with such a *Magnetical Virtue*, that if left

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to its liberty 'twill seat it self in a situation *North* or *South*. The *North* and *South-wind* thus assured by the motion of the Needle, the Mariner suppoeth his Ship to be upon some *Horizon* or other, the *Center* whereof is the Ship; so that crossing this *North* and *South-line* at *Right Angles*, sheweth the *East* and *West*; so you have the 4 *Cardinal Winds* cross each of these, and you have the 8 *Whole Winds*, another division makes 16, which again divided, makes 32 in all: And these *Lines* which a Ship following the direction of the *Magnetical Needle* describes upon the Surface of the Water, were by the *Portugals* called *Rumbs*, and is still continued. These *Rumbs* are represented upon the *Globe* by those *Helispherical* or *Spiral Lines* that you see divided into 32 parts, with a *Flower-de-luce* always pointing to the *North*.

The finding of the *Rumb* and *Distance* of a Ship in any place from whence she hath departed, is the last of the four things propounded as necessary in this Art of *Navigation*; which how to perform, shall be also shewed in the following *Problems*: But first of the *Latitude*.

PROB.

PROB. I.

To finde the Latitude.

I. *By the Suns Declination, and Meridian-Altitude.*

When the Sun is in the Equinoctial, having no Declination, and the Meridian-Altitude is observed on the

South-side of the Meridian,

The Meridian-Altitude taken from 90 degr. leaves the Elevation of the North-pole.

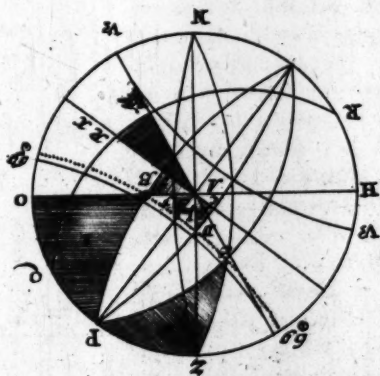
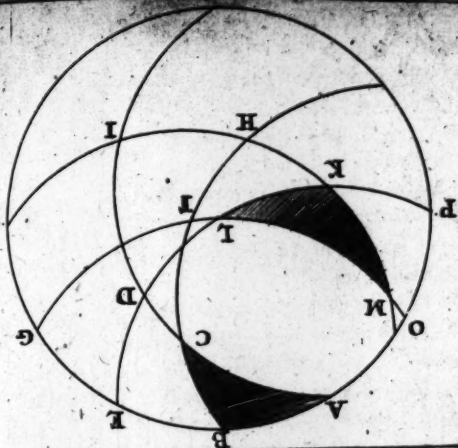
North-side of the Meridian,

The Meridian-Altitude taken from 90 degr. leaves the Elevation of the South-pole.

PROB.

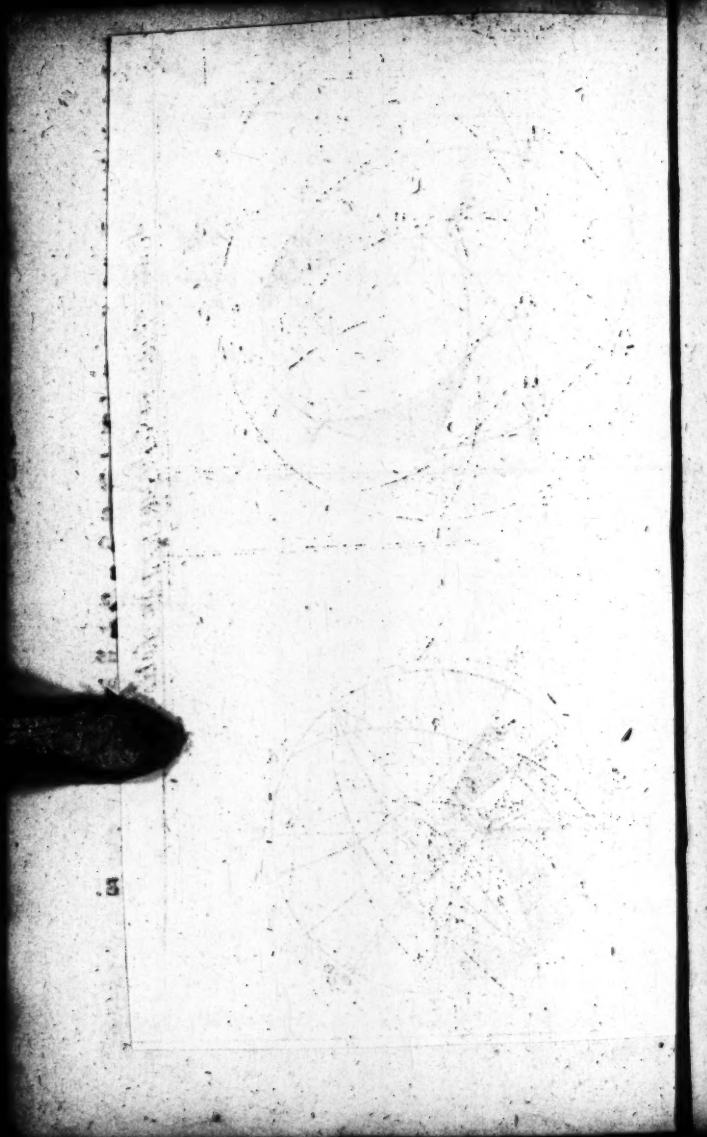
When

Place these 2 Schemes upon folio. 212



leaves the Latitude 50. 10.

when



When the *Suns Declination* is

North,

If the *Meridian Altitude* be less than 90 deg. and the *Sun* upon the *South*-side of the *Meridian*, the *Suns Declination* being taken from the *Meridian Altitude*, leaves the height of the *Equinoctial*; which taken from 90 deg. gives the *Latitude North*.

South,

If the *Meridian Altitude* be less than 90 deg. and the *Sun* upon the *South*-side of the *Meridian*, add the *Meridian Altitude* and the *Declination* together, their sum is the height of the *Equinoctial*; which taken from 90 deg. leaves the *Latitude North*. But if the sum of the *Declination* and *Altitude* exceed 90 deg. take 90 therefrom, the remainder is the *Latitude South*.

When the *Suns Declination* is

North,

If the *Meridian Altitude* be less than 90 deg. and the *Sun* upon the *South*-side of the *Meridian*, add the *Altitude* and *Declination* together, their sum is the height of the *Equinoctial*; which taken from 90 deg. leaves the *Latitude South*. — But if the sum be above 90 deg. take 90 deg. therefrom, the remainder is the *Latitude North*.

South,

If the *Meridian Altitude* be less than 90 deg. and the *Sun* upon the *North*-side of the *Meridian*, subtract the *Declination* from the *Meridian Altitude*, the remainder is the height of the *Equinoctial*; which taken from 90 deg. leaves the *Latitude South*. When

When the { *North,* } if the *Meridian Al-* { *North.*
Suns De- { *titude* be juſt 90 d.
clination { *the Suns Declinati-*
 is { *South,* } on is the *Latitude* { *South.*

If the *Meridian Altitude* be obſerved under the *Pole*, within the bounds of the *Polar Circles*, in ſuch Caſe the *Suns Declination* muſt be taken from 90 deg. and what remains is his diſtance from the *Pole*; which being added to the *Meridian Altitude*, the ſum is the *Latitude* of the place.

☛ Note here, that whatſoever is ſaid concerning finding of the *Latitude* by the *Suns Declination* and *Meridian Altitude*, the ſame is to be performed by the *Meridian Altitude* of any known *Star*: and the manner how to effect it, will beſt be ſeen by the *Globe*.

II. By the Meridian Latitude of a known Star.

Suppoſe that being at Sea I ſhould obſerve *Algol* to be upon the *South ſide* of the *Meridian*, and to have *Altitude* 62 deg. and I would know in what *Latitude* I then was.

Arithmetically.

The *Declination* of *Algol* is 39 deg. 39 min. *North*, the Complement whereof is 50 deg. 21 min. his diſtance from the *Pole*; add this diſtance and

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and his *Altitude* 62 deg. together, the sum is 112 deg. 21 min. which taken from 180 deg. leaves 67 deg. 39 min. for the *Latitude* of the place *North*.

By the Globe.

Bring *Algol* to the *Meridian*, and from the Centre of the *Star*, downwards, count his *Altitude* 62 deg. and mark that point upon the *Meridian*: then bring that point to the *South-part* of the *Horizon*, and you shall finde the *North-pole* to be elevated 67 deg. 39 min. which is the *Latitude* you are then in. In like manner, if you should observe

		d.	m.
The Bulls Eye	} upon the South-part of the Meridian, having Altitude	51	0
Spica Virginie		32	0
The Great Dog		72	0

	d.	m.
you would be in Latitude	54	48 N.
	67	31 S.
	34	14 N.

III. By observing of two Stars, one being upon the Meridian, and the other Rising or Setting.

Bring the *Star* which you see upon the *Meridian* unto the *Meridian*, and there holding the *Globe* fast, move the *Meridian* in the *Horizon*, till you see the other *Star* on the *East*. or *West*,
Rising

Rising or Setting, as you observed it, and then shall the *Globe* stand at the *Latitude* you are in.

So if you should see *Regulus* upon the *Meridian*, and *Lyra* rising towards the *East*, the *Latitude* would be found 37 deg. 50 min.

IV. By the Altitude of two known Stars, being both of them upon the same Azimuth or point of the Compass.

Lay the *Quadrant of Altitude*, or rather your thin *Brass-Semicircle* to both the *Stars*, at the proper degrees of *Altitude*, as you observed them to be in the *Heavens*; (for the difference of their *Altitudes* is equal to their distance.) Then turn the *Globe* about in the *Horizon*, till the *Quadrant* or thin *Plate* of *Brass* do touch the *Horizon* in that *Azimuth* (or point of the *Compass*) on which you observed the *Stars* to be; so shall the *Globe* rest at the *Latitude* you are in.

So *Capella* and *Scheder*, *Capella* being 20 deg. high, and *Scheder* 66 deg. high, and both of them upon the *North-East-point* of the *Compass*, you will finde your self to be by this observation in the *Latitude* of 40 deg. 0 min. *North-Latitude*.

V. *By the Altitude, Azimuth, and Declination of the Sun, or of a known Star.*

Suppose a fixed *Star*, as that in the Right Knee of *Hercules*, having 47 deg. 9 min. of *Declination*, should be observed at Sea to have 122 deg. of *Azimuth* from the North-part of the *Meridian*, and to be 60 deg. high; and from hence the *Latitude* were required:

Elevate the *Globe* to the *Stars Altitude* 60 deg. and from the *Pole* count the Complement thereof of 30 deg. to which screw the *Quadrant of Altitude*: also count 122 deg. upon the *Horizon* from the North-part of the *Meridian*, and to those degrees bring the *Quadrant of Altitude*, and there keep it; then turn the *Globe* about, till 47 deg. 9 min. the *Stars Declination* (counted upon the *Equinoctial Colure* from the *Equinoctial*) do cut the *Quadrant of Altitude*, and those degrees will cut the *Quadrant of Altitude* in 71 deg. 13 min. and that is the *Latitude* in which you then are.

VI. *By the Suns, or a Stars Declination and Amplitude.*

Let the *Sun* or a *Star* have 10 deg. of *North Declination*, and let the *Amplitude* thereof at its Rising or Setting be observed to be 57 deg. from the *North*.

Elevate the *Globe* to 33 deg. (the Complement

Q

ment of the *Amplitude*) and count the *Amplitude* it self 57 deg. upon the *Meridian* from the *Pole* forward, and thereto screw the *Quadrant of Altitude*, and bring the other end thereof to the *East* or *West-points* of the *Horizon*; then count 80 deg. (the Complement of the *Stars* or *Suns Declination*) from the *Pole* upon the *Equinoctial Colure*, and bring those degrees to the *Quadrant of Altitude*; so shall 80 deg. of the *Colure* cut 71 deg. 24 min. of the *Quadrant*, and that is the *Latitude* you are then in.

VII. By the *Suns Ascensional difference*, and *Amplitude*.

If the *Ascensional difference* be 27 deg. 7 min. and the *Amplitude* 33 deg. 20 min. and the *Latitude* were required;

Elevate the *Globe* to 27 deg. 7 min. the *Ascensional difference*, and from the *Pole* count the Complement thereof 62 deg. 53 min. and thereto screw the *Quadrant of Altitude*; then bring the *Equinoctial Colure* to the *Meridian*, and count upon the *Quadrant of Altitude* upwards, the Complement of the *Amplitude* 57 deg. 40 min. which degrees bring to the *Equinoctial*, and then shall the *Quadrant of Altitude* cut upon the *Horizon* 51 deg. 30 min. counted from the *East* or *West*, which is the *Latitude* of the place.

And if you count the degrees of the *Equinoctial* comprehended between the *Meridian* and the *Quadrant of Altitude*, you shall finde them to be 20 deg. 5 min. which is the *Suns Northerly Declination* at that time.

VIII. By

VIII. *By the Suns or a Stars Declination, and the time that he is upon the East or West-points of the Compass.*

Let the *Sun* or a *Stars Declination* be 15 deg. North, and let the time that the *Sun* is upon the East or West-points of the Compass, be 59 deg. 45 min. which in time is 3 hours 56 min. and hence let the *Latitude* be required.

Elevate the *Globe* to 15 deg. the *Declination*, and screw the *Quadrant of Altitude* to 75 deg. the *Zenith-point*; then count 59 deg. 45 min. or 3 hours 56 min. (the hour) upon the *Horizon* from the *South*, Eastward or Westward; and thereto bring the *Quadrant of Altitude*: Then look what degrees or the *Quadrant* are cut by the *Equinoctial*, and you shall finde 28 deg. counted from the *Zenith*, and that is the *Latitude* sought.

And thus have you several ways both by the *Sun* and *Stars* to finde the *Latitude* at any time.

I will now proceed to some other *Problems* for finding the *Rumb* and distance, which as was said is the last of the four things necessary in the Art of Navigation.

P R O B. II.

Any two places given, to finde their Rumb.

Defini- Those Lines which a Ship following the
tion.] direction of the *Magnetical Needle* describeth on the surface of the Sea, are called

*Rumb*s, and arc (as was said) described upon the *Terrestrial Globe* by certain *Spiral Lines*; for the better understanding whereof, I shall premise these few Propositions:

First, The *Needle* touched with the *Load-stone*, pointeth out the common Intersection of the *Horizon* and *Meridian*; the one end respecting the *North*, the other the *South*, as aforesaid.

Secondly, A Circle drawn through the *Vertex* of any place that is distant from the *Equator*, cannot cut divers *Meridians* at equal *Angles*.

Thirdly, A great Circle drawn through the *Vertical-point* of any place, and inclining to the *Meridian*, maketh greater *Angles* with all other *Meridians*, than with that from whence it was drawn.

Fourthly, If we sayl upon any point of the *Compass* except *North* or *South*, we often change our *Horizon* and *Meridian*.

Fifthly, The same *Rumb* cutteth all *Meridians* of all places at equal *Angles*, and respecteth the same *Quarters* of the *World* in every *Horizon*.

Sixthly, The portions of the same *Rumb* intercepted between any two *Parallels* whose difference of *Latitude* is the same, are also equal to each other: therefore an equal Segment of the same *Rumb* equally changeth the difference of *Latitude* in all places; so that in an equal space pass'd in one and the same *Rumb*, one of the *Poles* is equally elevated; and the other depressed.

Seventhly, *Rumb*s though never so far continued, do not pass through the *Poles*, but winde about the *Poles* until they loose themselves.

Hence you may understand if your *Ship* be directed

rected under the North or South-Rumb, your course will be always under the same Meridian; if under the East or West-Rumb, you will either describe the Equator, or a Circle parallel to it: If your Vertical point be under the Equator, your Ship will describe an Arch or Segment of the Equator; but if your Zenith or Vertical point be distant from the Equator either North or South, your course will then describe a Parallel as far distant from the Equator, as the Latitude of the place is whence you first set forwards: But if your Voyage be to be made under the Rumb which inclineth to the Meridian, your course will then be neither in a greater or lesser Circle, but your Ship will describe a kinde of a crooked spiral Line.

Practice.] Finde the two places upon the Globe, and when you have found them, see what one Rumb-line passeth through both of them, and that is the Rumb or point of bearing of those two places one from the other. So C. del Gade on the Coast of Zanguebar and C. Cormorin are both of them found upon the W S W and E N E Rumb, and that is their Point of bearing, or Rumb required.

If you can finde no one Rumb that passeth through both your places, then you must look what Rumb-line upon the Globe runneth most parallel to both the given places, and conclude that to be the point or Rumb of those two places bearing one from another. — So if the two places were Scirra Liona in Africa, and the Island S. Hellena, if you look upon the Globe you shall finde no one Rumb-line to pass through both the places.

places, but that *Rumb* to which the places lie most parallel, is the *NNW* and *SSE Rumb*; and so *Sierra Liõa* beareth from *S. Hellena* *NNW*, and on the contrary *S. Hellena* is situate from *Sierra Liõa* *SSE*, which is the *Rumb* required.

PROB. III.

Having the distance sailed, and the Rumb you have sailed upon given, to finde the difference of the two places both in Longitude and Latitude.

HAVING found the *Rumb* upon which you made your course, make a small mark thereupon, for the place you departed from: then from the *Equinoctial* take the number of miles or leagues you have sailed upon that *Rumb* (allowing 20 leagues for a deg.) and set that distance upon the *Rumb* from the former point made; and at the termination of your number of miles or leagues, make a second mark upon the *Rumb*: then bringing the place, or point, you departed from to the *Meridian*, you shall there finde the *Latitude* of that place or point, and the *Meridian* cutting the *Equinoctial* will shew you the *Longitude* of that place or point. — Do so by bringing the second point or place to the *Meridian*, and there shall you finde the *Latitude*, and upon the *Equinoctial* the *Longitude* of that place or point. Now if you subtract the lesser *Latitude* from the greater, you have the difference of *Latitude*; and the lesser *Longitude* subtracted from the greater, gives the difference of *Longitude*.

PROB.

P R O B. IV.

The Latitude of two places, and the Rumb that the two places bear each from other given, to finde the difference of Longitude of those two places, and also their distance upon the Rumb.

Practise.] **F**irst, finde the *Rumb* upon the *Globe*, and turn the *Globe* about till that *Rumb* doth cut the *Meridian* in the *Latitude* of the first place from whence you departed, and there make a mark or point upon the *Rumb*, and at the same time see also what degrees of the *Equinoctial* are cut by the *Meridian*; for that is the *Longitude* of the first point.

Secondly, Turn the *Globe* about, till the same *Rumb* does cut the *Meridian* in the *Latitude* of the second place, and there make another mark upon the *Rumb*; and also see what degrees of the *Equinoctial* are cut by the *Meridian*, which degrees are the *Longitude* of the second point or place: and the lesser *Longitude* being subtracted from the greater, gives the difference of *Longitude* of the two places or points.

Then for the distance upon the *Rumb*, the distance between the two points before made, being measured upon the *Equinoctial*, and reduced to miles or leagues, shall give the distance upon the *Rumb*,

¶ Here

Here note, that the distance upon the *Rumb* being intirely taken and applied to the *Equinoctial*, will give the distance in the Arch of a great Circle, and not really in the *Rumb*, for the distance upon the *Rumb* will be always greater than the great Circular distance: wherefore the better way will be, to take in a pair of Compasses one, two, three (or some small number of) degrees of the *Equinoctial*, and run that distance over upon the *Rumb-line* from point to point; and the number of all those returns of the Compasses (reduced to miles or leagues) shall be the neer distance of the two places upon the *Rumb*.

F I N I S.

